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EFFECTS OF VARIED ENHANCEMENT STRATEGIES (CHUNKING, FEEDBACK, GAMING) IN COMPLEMENTING ANIMATED INSTRUCTION IN FACILITATING DIFFERENT TYPES OF LEARNING OBJECTIVES

A Thesis in Instructional Systems

by

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ABSTRACT

The purpose of this study was to examine the instructional effectiveness of different levels of chunking (simple visual/text and complex visual/text), different forms of feedback (item-by-item feedback, end-of-test feedback and no feedback), and use of instructional gaming (game and no game) in complementing animated programmed instruction on a test measuring different educational objectives.

Previous research suggested that chunking of information helped reduce cognitive load, concentrating on important information. Feedback is an essential part of any type of instruction designed to help students learn more effectively. However, no one best type of feedback has been found to be most effective for computer-based education. Games have the potential of facilitating different types of learning outcomes by motivating students and allowing them to rehearse without cognitive load. This interactive information rich environment could cause cognitive overload if game factors such as clear goals, challenges and immediate feedback are not identified and designed clearly. That is why we need better models in order to understand what kinds of games, what types of feedback and chunking facilitate achievement of different types of learning objectives.

A total of 360 subjects participated in this study. A Posttest-Only 2 x 3 x 2 factorial experimental design was employed. Each participant was randomly assigned to one of twelve treatments (1) simple chunks + item-by-item feedback + game with programmed instruction with animation; (2) simple chunks + item-by-item feedback + no game with programmed instruction with animation; (3) simple chunks + end-of-test feedback + game with programmed instruction with animation; (4) simple chunks + end-of-test feedback + no game with programmed instruction with animation; (5) simple chunks + no feedback + game with programmed

instruction with animation; (6) simple chunks + no feedback + no game with programmed instruction with animation; (7) complex chunks + item-by-item feedback + game with programmed instruction with animation; (8) complex chunks + item-by-item + no game with programmed instruction with animation; (9) complex chunks + end-of-test feedback + game with programmed instruction with animation; (10) complex chunks + end-of-test feedback + no game with programmed instruction with animation; (11) complex chunks + no feedback + game with programmed instruction with animation; and (12) complex chunks + no feedback + no game with programmed instruction with animation.

Multiple Analysis of Variance (MANOVA) was used to determine whether the mean post test scores of the treatment groups differed significantly from one another, whether the factors: A (simple visual/text and complex visual/text chunking); B (item-by-item feedback, end-of-test feedback, no feedback); C (game, no game) interacted significantly with one another with respect to each of the criterion measures being investigated, and specific items which were enhanced by different strategies. The enhanced items were categorized as follows: EIC = Identification questions enhanced with chunking, EIG = Identification questions enhanced with gaming, ETC = Terminology questions enhanced with chunking, ETF = Terminology questions enhanced with feedback, ETG = Terminology questions enhanced with gaming, ECC = Comprehension questions enhanced with chunking, ECF = Comprehension questions enhanced with feedback, ECG = Comprehension questions enhanced with gaming.

There were no statistically significant interactions among the different strategies on the different criterion measures (identification, terminology, comprehension and total). There were no statistically significant main effects with respect to the use of chunking strategies (simple visual/text and complex visual/text), and different types of feedback (item-by-item, end-of-test, and no feedback) in complementing programmed instruction with animation among the 12 treatment groups. There were statistically significant main effects with respect to the use of gaming among treatment groups on terminology and comprehension tests. There were also statistically significant main effects when focusing on items enhanced by different strategies when gaming was a factor on the terminology and comprehension tests.

The research findings indicated that gaming was an effective and motivational method to rehearse the information without causing cognitive load. Contrary to previous studies, chunking strategies were not statistically significant in this study. This might be related to the way chunking strategies were presented and their location in the instructional unit. Presenting chunking strategies along with additional strategies required the participant to process more information in a short amount of time. This could also cause information overload. In addition, feedback was important but, like in previous studies, this study did not indicate any statistically significant difference among the different types of feedbacks. Providing different types of feedback without knowing how learners would perceive, process and interpret the information might have caused cognitive load and performance of learners.

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CHAPTER I

THE NEED FOR THE STUDY

Introduction

Gagne and Medsker (1996) define learning as “a relatively permanent change in human disposition or capability that is not ascribable simply to process of growth” (p.46). However there are other perspectives which define learning. Skinner, the most noted behaviorist, provides the early definition of learning as “... a change in probability of response but we must also specify the conditions under which it comes about” (Skinner, 1950, p.199). Vygotsky and Bandura believe that consciousness is the end product of socialization. Learning first occurs on a social level and then on the individual level. They explained that learning comes from observation through modeling: from observing others a person can form ideas of how new behaviors are performed, and on later occasions this coded information serves as a guide for action (Bandura, 1977).

The common definition is that learning is a permanent change in behavior or thought resulting from some sort of intervention. There is still a need to know what those interventions are that made learning occur. It is important for us as educators and instructional designers to have an increased understanding of how people learn and how to support learning.

The Role of Animation

Animation is a sequence of images played in rapid succession such that to the human eye the result is apparent motion (Park & Gittelman, 1992). Dwyer and Dwyer (2003) define it simply as pictures in motion (Dwyer & Dwyer, 2003). Current educational use of animation suggests two main underlying assumptions about their role in learning. Firstly, *affective* function, that is, to attract attention, engage the learner, and sustain motivation. Affectively-oriented animation often portrays activity that is humorous, spectacular, or bizarre but that may have little to do with facilitating comprehension of the subject matter itself. Secondly, *cognitive* function, in this role, animations are intended to support students' cognitive processes that ultimately result in them understanding the subject matter (Lowe, 2004). The main focus of this study was on animation's role of gaining attention to the information with which students have difficulty. However it was expected to help learners to understand better that information.

The Role of Chunking

A chunk is a manageable unit of information. The notion of chunking to reduce cognitive load is well documented in the research literature (Simon, 1974). Miller (1956) concluded that the capacity of short-term memory is 7 ± 2 chunks. Simon (1974) added that it takes 5 to 10 seconds to fixate each chunk into long-term memory. The amount of time to process information is relatively constant, and the number of words processed per unit of time depends on the size of the chunk. Chunks also play the role of conditions of productions. Each familiar chunk in long-term memory (LTM) is a condition that may be satisfied by the recognition of the perceptual pattern and that evokes an action (Newell & Simon, 1972). “Simple examples of chunking include grouping individual letters such as c-a-t, into a single unit, cat. More complex chunking involves detailed linguistic descriptions that are organized into single idea units.” (Hunt & Ellis, 1999, p. 104). Chunking's role, in this study was helping students rehearse important information without cognitive overload, and also increase the interactivity with learner and learning module.

The Role of Feedback

Feedback is the message which follows the response made by a learner in a learning situation. It refers to an event that provides a learner with information about the correctness of his or her response (Batino, 1992). There are several outcomes of feedback including reinforcement, information provider and motivator (Zamel, 1981). One of the most important outcomes of feedback is helping learners identify errors and become aware of misconceptions (Mason & Bruning, 2001). Feedback empowers active learners with strategically useful information, thus supporting self-regulation (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991). It may allow incorrect mental content to be repaired or replaced and useful mental linkages to be strengthened (Pashler, Cepeda, Wixted, & Rohrer, 2005).

Whether it is a reinforcer, information provider or motivator, feedback is essential for any learning environment. In this study feedback's role was to provide information about their response and allowing them to rehearse the information.

The Role of Gaming

A game is a set of activities involving one or more players. It has goals, constraints, payoffs, and consequences. A game is rule guided and artificial in some respects. Finally a game involves some aspects of competition even if that competition is with itself (Dempsey, Lucassen, Haynes, & Casey, 1996). Computer games offer a programmed environment by which the student can play, experiment and learn from mistakes and feedback. Games provide better interactive interface, digital story telling environment and in time bounded situations tests the analytic and decisive power of the player (Squire, 2005). Computer games enhance learning through visualization, experimentation and creativity of play (Amory, Naicker, Vincent, &

Adams, 1999). In this study computer games' role was motivating learners and rehearsing the content before the learners are tested.

Justification for Research, Theory, and Education

Recent studies suggest that gaming can motivate and interest learners (Demsey, Lucassen, Ramussen, 1996; Gee, 2003); game playing increased retention of subject materials (Demsey et al, 1996), improved higher order learning skills (Reiber, 1996). Unfortunately there is little consensus on game features that support learning, the process by which games engage learners or the types of outcomes that can be achieved through game play (Garris, Ahlers, & Driskell, 2002).

Computers now make it possible to produce highly interactive forms of animation that give the user extensive control over the way subject matter is presented (Lowe, 2004). However researchers recommend caution. Reiber (1990) stated: "Although much research has been done on effects of non-static visuals (Dwyer 1978, for example), little research has been conducted on animation's instructional effects. Empirical data that are available are inconsistent" (p. 78).

The volume of information is increasing very rapidly. Knowledge and skills to be gained and to be taught in the workplace or school are also increasing. More and more people want to obtain more education in order to cope with the increased information. Technology is rapidly changing as well and thereby creating new opportunities by making more resources available for individuals. The increased complexity in science exceeds human capability. Information overload is a fact of life. While it is not possible to eliminate the complexity, it is possible to manage it (Molnar, 1997).

Computer-based instruction (CBI) is used increasingly and animation is an important part of CBI. Feedback has been viewed as a critical element in the learning process. Gaming activities are growing because of the more sophisticated software and hardware availability to schools and individuals. It is important to provide support by empirical research as to what makes animated instruction effective. What kind of animation should be used or should not be used for instruction? Also how does one incorporate computer games into learning environments? What kind of game should be used or not to be used for instruction? What type of feedback helps learners' improvement?

Justification for Theory

There are two theories that are involved in designing visuals for learning. They are Cognitive Load Theory and Dual Coding Theory.

Cognitive load theory is based on limits of working memory in which all conscious cognitive processing occurs. Long-term memory provides humans with the ability to expand this processing unlimitedly, holding cognitive schemas that vary in their degree of complexity and automation (Sweller, 2004). When asked to think about or process too much information at any given moment the mind simply does not process it all. Sensitivity to working memory is critical to our success as instructional designer (Lohr, Roberts, & Gall, 2003). Cognitive load theory is particularly important for investigations into cognitive processes and for the instructional designer who creates visual environments that will support the learning process. Cognitive load theory has three categories: intrinsic, extraneous, and germane. Intrinsic cognitive load depends on working memory capacity imposed by element interactivity. Element interactivity refers to levels of complexity of information on a continuum from low to high. Low element interactivity can be understood and learned individually without consideration of any other elements. High element interactivity materials can be learned individually but cannot be understood until all of the elements and their interactions are processed. That is why high element activity materials are difficult to understand. Element interactivity refers to the processing of various types of information by learners (Van Merrienboer & Ayres, 2005).

Extraneous cognitive load refers to the processes that are not directly necessary for the particular learning. They tend to manifest in situations where the learner has no strong problem-solving skills. The learner might be overloaded when presented with multiple choices of methods available for solving some problem. Consequently the processes can be altered by a variety of instructional interventions (Van Merrienboer & Ayres, 2005).

Germane cognitive load is associated with processes that are directly relevant to learning. Such processes help learners to sift through information, distinguishing the relevant from the irrelevant, and constructing strategies that are best suited to particular similar or novel situations (Van Merrienboer & Ayers, 2005).

Dual Coding Theory proposed by Paivio (1971, 1986) and Clark and Paivio (1991) goes deeper into information processing and focuses on the encoding process, and suggests that there are actually parallel and independent processing channels for information to be encoded in. The theory assumes that there are two cognitive subsystems, one specialized for the representation and processing of nonverbal objects/events (i.e., imagery), and the other specialized for dealing with language. Paivio also postulates two different types of representational units: "imagens" for mental images and "logogens" for verbal entities which he describes as being similar to "chunks" as described by Miller. Logogens are organized in terms of associations and hierarchies while imagens are organized in terms of part-whole relationships. Dual Coding Theory identified three types of processing: (1) representational, the direct activation of verbal or non-verbal representations, (2) referential, the activation of the verbal system by the nonverbal system or vice-versa, and (3) associative processing, the activation of representations within the same verbal or nonverbal system. A given task may require any or all of the three kinds of processing (Clark & Paivio, 1991).

Problem Summary

The creation of animations is expensive and time consuming. Given the educational potential, together with the time consumption, creation highlights the necessity and importance of using computer animations as learning objects in order to ensure efficient reusability. It is therefore of increasing importance to establish animations with optimal instructional design properties (Huk, Steinke, & Floto, 2003).

We need better theoretical models of how games function to produce learning. What kind of learning takes place as a result of playing the games? How is this learning transferred to other learning situations (Squire, Giovanetto, Devane, & Durga, 2005)?

Feedback has two functions: to verify and elaborate (Kulhavy & Stock, 1989). Informative feedback has to be considered an important factor of sufficient learning in computer-based instruction (Narciss & Huth, 2002). Unfortunately the past research findings on the multiple forms of feedback are inconsistent (Kulik and Kulik, 1988). We need to understand what types of feedback most effectively help learners to achieve different educational objectives in an online environment.

Problem Statement

The purpose of this study was to investigate the instructional effectiveness of different levels of chunking (simple visual/text, and complex visual/text), different forms of feedback (item-by-item feedback, end-of-test feedback and no feedback), and use of instructional gaming (game, no game) in complementing animated programmed instruction on a test measuring different educational objectives. Specific research questions to be answered through this study were as follows:

1. Is there a significantly interactional effect among the different levels of chunking, different forms of feedback and instructional gaming?
2. Is there a significant difference in achievement between students who received different levels of chunking (simple visual/text or complex visual/text) on a test measuring different educational objectives?
3. Is there a significant difference in achievement among students who received different types of feedback (item-by-item, end-of-test, no feedback) on a test measuring different educational objectives?
4. Is there a significant difference between students who received game and no game treatments on a test measuring different educational objectives?

Statement of Hypotheses

Ho:1. There is no significant interaction among the treatment groups on the tests measuring different educational objectives.

Ho:2. There are no significant differences in achievement between students in the different levels of chunking treatment groups (simple visual/text and complex visual/text) on the tests measuring different educational objectives

Ho:3. There are no significant differences in achievement among students in the different forms of feedback treatment groups (item-by-item, end-of-test and no feedback) on the tests measuring different educational objectives.

Ho:4. There are no significant differences in achievement between students between the game and no game treatment groups on tests measuring different educational objectives.

The Delimitations

This study was limited to undergraduate Pennsylvania State University students who were not biology or pre med majors. Teaching and learning strategies were limited to animation, two types of chunking (simple visual/text and complex visual/text), three types of feedback (item-by-item and end-of-test, no feedback), and computer gaming (game and no game).

The Definitions of Terms

Animation: Visuals in motion (Dwyer & Dwyer, 2003).

Chunk: a pattern or cluster of pieces (Gobet and Simon, 1998a).

Text Chunking: is dividing sentences into non-overlapping segments (Abney, 1991).

Visual Chunking: Based on text chunking, visual chunking can be defined as dividing static images into segments.

Simple chunk: A group of words or sentences that explains only one content.

Complex Chunk: A group of simple chunked words or sentences that explains related content at one time.

Feedback: is any message generated in response to a learner's actions (Mason & Bruning, 2001).

Item-by-Item Feedback: is a message that was given right after the learner's response to each practice test question to inform the learner about the correctness of his or her response, with a short explanation.

End-of-Test Feedback: is a message that was given after the completion of each practice test to inform the learner about the correctness of his or her response, with a short explanation on each question.

Game: A game is a set of activities involving one or more players. It has goals, pay offs and consequences (Dempsey, Lucassen, Haynes, & Casey, 1996).

Computer Game: is a game played individually or collaboratively on a computer.

Programmed Instruction: is a type of self-paced instruction which allows learners to check the accuracy of their responses through the use of immediate feedback (Dwyer, 1978, p. 7).

Student Achievement: The test scores that are achieved in identification, terminology, and comprehension tests in the heart content.

Rehearsal: **"**Repetition of information in short-term memory, which allows information to be recognized, retained, or organized for long-term memory. Rehearsal may be covert, requiring only mental activity, or overt, requiring both mental and physical activity" (Dwyer, 1990, p. 25).

Information Processing: The Information Processing Model shows insight into the cognitive nature of the human thought process. From attention gaining, to an emitted stimulus through feedback and perceived performance, a thought process is a full cycle. To facilitate desired learning outcomes one should know what occurs in the various phases of the cycle. It is imperative to design instruction to facilitate learning. Education should support the cognitive processes of the brain by activating mental sets that affect attention and selective perception, enhance encoding by providing necessary organization for the new data, and maintain executive control that keeps the instruction going in the right direction (Gagné and Medsker, 1996). Creating and implementing effective learning strategies (sequencing, organizing and structuring) are important factors to the successful transfer of information into Long Term Memory.

Taxonomies: "Taxonomies of instructional learning targets are highly organized schemes for classifying learning targets into various levels of complexity. Generally, educational taxonomies fall into one of three domains: (1) Cognitive domain: Outcomes focus on knowledge and abilities requiring memory, thinking, and reasoning process, (2) Affective domain: Outcomes focus on feelings, interests, attitudes, dispositions, and emotional states, (3) Psychomotor domain: Outcomes focus on motor skills and perceptual process." (Nitko, 2001, p. 26).

Chunking, Information Processing, and Taxonomies: Information load occurs in working memory, which has a limited storage capacity, when it becomes full. The learner could not take more information and becomes frustrated and, ultimately, learning suffers. A novice learner could reach information load before an expert learner. Chunks are manageable units of information that make it easier to remember and reduce the information overload. They improve the reading comprehension and ability to access and retrieve more of the information, improve learners' performance, computation and problem solving (Harrelson & Leaver-Dunn, 2003). Chunking strategies may increase working memory ability and allow flexibility.

Taxonomies and Chunks both allow the learner to narrow down the information, reduce complexity; and taxonomies clarify relationships among classes of information that help creating chunks (Nitko, 2001).

Information processing, feedback and gaming: The depth of information processing is facilitated by rehearsal of the stimulus in short-term memory. Both feedback and gaming have the function as the rehearsal activities by facilitating the organization and retention of instructional content (Dwyer and Dwyer, 1985). The time spent interacting with the content material facilitates the movement of information into short-term memory and subsequently into long-term memory (Petterson, 1989).

The Conceptual Assumptions

Based on research it is assumed that chunking of information is an effective way of presenting information to students of all ages and abilities. Feedback is also known to be an effective means of improving learning. It is further assumed that all the subjects know the basic applications of computer use such as using the mouse, browsing on a page, and using links. Finally the test scores administered are valid and possess acceptable reliability.

The Importance of the Study

This was an experimental research study to determine if learners exposed to different level of chunking strategies and different types of feedback complemented with animated instruction and a computer game would show significant gains in achievement of different types of learning objectives. Psychological studies guided by information theory have shown that people focus their attention by concentrating on important information, by ignoring information they perceive to be irrelevant, and by placing information details into chunks (Garner, 1962, 1974; Keyes & Krull, 1992). People learn using cognitive strategies. We can help students to learn more effectively by helping them learn how to learn, by explicitly modeling and using cognitive strategies in the activities. Research suggests that feedback helps students learn more effectively, and that it promotes higher levels of long-term retention (Semb & Ellis, 1994, Ellis & Semb, 1998; Buzhardt & Semb, 2002).

Technology advances make it relatively easy for animations and computer games to be generated and delivered. Presenting educational content through the Internet has made more use of animated interactive instruction and computer games. However, there is growing evidence that animation may not always be beneficial for learning. This research explored college students' extraction of information from animated instruction supported by chunking, feedback and gaming in terms of different types of learning objectives and suggested practical ways to maximize the effectiveness of these strategies in complementing animated instruction.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Chunking

Information is not processed in single strands or discrete entities but as chunks of similar equivalent data (Simon, 1974). Chunks also play the role of conditions of productions. Each familiar chunk in long-term memory (LTM) is a condition that may be satisfied by the recognition of the perceptual pattern and that evokes an action (Newell and Simon, 1972). “Simple examples of chunking include grouping individual letters, c-a-t, into a single unit, cat. More complex chunking involves detailed linguistic descriptions that are organized into single idea units.” (Hunt & Ellis, 1999, p.104).

When presented a "large" set of elements to remember, it is often helpful to combine the elements to form a smaller number of groups. Each of the groups is referred to as a "chunk" of information. Chunking does not need to be based upon any underlying meaning or logic that can be identified within the elements of the to-be-learned information. However, if an underlying meaning or logic can be identified and is used to define the chunks, then remembering is greatly enhanced (Cooper, 1998).

Miller’s (1956) findings concluded that the span of absolute judgment and the span of immediate memory impose severe limitations on the amount of information that we are able to receive, process, and remember. By organizing the stimulus input simultaneously into several dimensions and successively into a sequence or chunks and summarized evidence that people can remember about 7 chunks in short-term memory (STM) tasks. The capacity of working memory is limited (Miller’s 7 ± 2) but can be enhanced through chunking (Miller, 1956).

Cowan's theoretical framework "focuses of attention" is capacity-limited, and that recalled information is restricted to this limit in the focus of attention and suggested real capacity limit is only 3 to 5 chunks. Based on visual and verbal chunking, capacity limits will be useful in analyses of information processing only if the boundary conditions for observing them can be carefully described. Four basic conditions in which chunks can be identified and capacity limits can accordingly be observed are: (1) when information overload limits chunks to individual stimulus items, (2) when other steps are taken specifically to block the recoding of stimulus items into larger chunks, (3) in performance discontinuities caused by the capacity limit, and (4) in various indirect effects of the capacity limit. Under these conditions, rehearsal and long-term memory cannot be used to combine stimulus items into chunks of an unknown size; nor can storage mechanisms that are not capacity-limited, such as sensory memory, allow the capacity-limited storage mechanism to be refilled during recall. A single, central capacity limit averaging about 4 chunks is implicated along with other, non-capacity-limited sources. The pure STM capacity limit expressed in chunks is distinguished from compound STM limits obtained when the number of separately held chunks is unclear (Cowan, 2001).

Chase and Simon (1973) developed a technique (Chunking Theory) for isolating and studying perceptual structures chess players perceive based on Elementary Perceiver and Memorizer (EPAM). EPAM is a component of a general, unified theory of cognition between feature extraction mechanisms and semantic and procedural memory. It is mainly interested in high-level recognition processes in memory (Feigenbaum & Simon, 1984, Feigenbaum & Simon, 1962; Feigenbaum, 1963; Gobet & Simon, 1998b). This is the classic recall task that has been used to show that subjects recall information in chunks. Chase and Simon, using perceptual visual chunking, studied three chess players from varying strength (from master to novice) in two different tasks. One a perception task where players reproduced a chess position in plain view; second players reproduced a chess position after viewing it for five seconds. Successive glances at the position in the perceptual task and long pauses in the memory task were used to segment structures in reconstruction protocol. Size and nature of structures were analyzed as a function of chess skills. Their findings included given a perception task and a memory task from a briefly exposed position chess players from varying strength extract different amount of information according to their strength. Superior performance of stronger players depends on their ability to encode the position into larger perceptual chunks (first estimate 50,000 chunks), each consisting of a familiar sub-configuration of pieces (Chase & Simon, 1973).

Simon and Gobet (1998a) re-examined experimentally the finding of Chase and Simon (1973) that the differences in ability of chess players at different skill levels to copy and to recall positions are attributable to the experts' storage of thousands of chunks in long term memory. Despite important differences in the experimental apparatus, the data of the present experiments regarding latencies and chess relations between successively placed pieces were highly correlated with those of Chase and Simon. They concluded that the chunks are larger than estimated by Chase and Simon but that as they showed, the pattern of relations between two pieces placed successively are radically different when the pieces do or do not belong to the same chunk. They explained that the large chunks are built around templates that encode information, acquired by strong players over years of practice and study about typical and familiar positions and that provide rapidly fillable slots for additional chunks of information about the current position (Simon & Gobet, 1998a). Gobet (1998a) also compared four theories on expert memory that were Chase and Simon's chunking theory, Holding's SEEK theory, Ericsson and Kintsch's long-term working memory theory, and Gobet and Simon's template theory. The empirical areas showing the largest discriminative power include recall of random and distorted positions, recall with very short presentation times, and interference studies. Contrary to recurrent criticisms in the literature, it is shown that the chunking theory is consistent with most of the data. However, the best performance in accounting for the empirical evidence is obtained by the template theory. The theory, which unifies low-level aspects of cognition, such as chunks, with high-level aspects, such as schematic knowledge and planning, proposes that chunks are accessed through a discrimination net, where simple perceptual features are tested, and that they can evolve into more complex data structures (templates) specific to classes of positions. Implications for the study of expertise in general include the need for detailed process models of expert behavior and the need to use empirical data spanning the traditional boundaries of perception, memory, and problem solving (Gobet, 1998a). This study utilized the visual type of chunking.

Chunk Hierarchy and Retrieval Structure (CHREST) is a computational model of expert memory in chess players and based on EPAM model of perceptual memory. CHREST possesses an input device (simulated eye), a visual short-term memory (STM) for storing intermediate results (equivalent to focus of attention), and a long term memory (LTM) based around a discrimination network for retrieving chunks of information. Each chunk learnt from information in the visual field, using STM to compose information across one or more eye fixations (Lane, Gobet, & Cheng, 2000). Chunks in performance may be observed in the output because of explicit representation in the system's LTM; or because the output has matched a stored chunk based on some similar criterion; or on a functional composition/decomposition dichotomy of the stimulus and its subcomponents. The three processes that produce chunking behavior show how the characteristics of chunks are interrelated with learning. However this understanding is only limited until a complete history of a subject is examined fully in terms of chunk manipulation in STM (Lane, Gobet, & Cheng, 2000).

Holding (1992) criticized Chunking Theory as an explanation for chess skill in particular and for expertise in general and proposed instead SEEK (Search, Evaluation, Knowledge) Theory. Holding explained five weaknesses of chunking theory: (a) Encoding into LTM is faster than proposed by chunking theory, (b) The size of chunks too small to reflect conceptual knowledge, (c) Memory for random positions sometimes shows skill differences, (d) The number of 50 chunks necessary for expertise is inflated, (e) verbal knowledge and processing neglected by the chunking theory (Gobet, & Simon, 1998b).

Gobet and Simon answered (1998b) these comments A and B that their extension to the theory (1996) that does not impose a limit on the size of chunks and proposes that chunks recur often evolve into more complex structures called templates. Templates have positions for variables, which allow values to be encoded and stored rapidly hence account for rapid LTM storage showed by chess players and remove criticism A.

Criticism C backed by Goldin's (1979) recognition experiment, loses much of its significance that chunking theory correctly predicts a skill difference in the recall of random chess positions. Criticism D addresses Simon and Gilmartin's estimate that it takes from 10.000 to 100.000 chunks to reach expertise in chess and any complex domain. Simon and Gobet have recently showed that chunks do encode information about the location of pieces and is not inflated (Gobet, & Simon, 1998b).

Chen and Mcgrath (2003) study examined the nature of student engagement (enjoyment, concentration, perceived control, exploration and challenge) in four hypermedia design tasks:

chunking, linking, naming, naming paths, and organizing information along with the impact of designing hypermedia documents on students' conceptual learning. This study was conducted in a mid western high school. Using the visual type of chunking, the researchers observed and interviewed two consecutive sections of a sophomore-level science class as students designed hypermedia documents to represent their understanding of the concepts covered in the sub-unit on Water. A total of 44 students were in two sections. The findings showed a high degree of student engagement in organizing information, elaboration of concepts in students' final knowledge representations. Although there were individual differences in students' cognitive engagement and conceptual learning the highly motivating task of organizing information and the characteristics of learning context sustained their engagement in cognitively complex and challenging tasks. The majority of the students' knowledge structures initially exhibited little organization of the concepts and reflected stereotypical grouping of concepts. Initial conceptual clusters were highly idiosyncratic, reflecting students' ability, common language understanding, and some misconceptions of terms. Nearly all students' final knowledge structures contained more chunks and included more concept in cluster than the original structures. The average number of chunks increased from 3 (range 0-11) to 6.44 (range 2-12) with the total number of chunks increasing from 43 to 103. The average size at the beginning of the project was 2.35, it increased to 3.52 at the end of the project. The changes in students' conceptual patterns not only provided quantitative evidence of conceptual development, but also reflected students' increase in accurate and thoughtful representation of concepts (Chen & Mcgrath, 2003).

Plate (2000) explained the relations between holographic reduced representations (HRRs) and chunking and memory organization. HRRs are a method for encoding nested relational structures in fixed-width vector representations. HRRs provide a natural method for chunking, breaking large structures into pieces of manageable size and indexing them (Plate, 2000). Forty first-grade and 40 seventh-grade students randomly drawn were administered 4 study trials on list of 4 sentences in Vanevery and Rosenbergs' research on semantics, phrase and age as variables in sentence recall. Half of the students at each age level were given semantically well integrated (SWI) sentences to learn, while the other half were given semantically poorly integrated (SPI) sentences. The sentences were constructed with the assistance of college associative sentence forms. The students tested in isolated rooms, the order of testing the children from different grades and conditions was random. Students were told that they would have four sentences to read to them and they were to remember as many of as they could. A 2X2 factorial analysis of variance was performed on the data. For all measures of recall, the SWI sentences were recalled significantly better than the SPI sentences regardless of age. In addition, the words in SWI were receded into larger chunks for storage than the words in SPI sentences, and age tended to increase chunking for both SWI and SPI sentences. The phrase chunking was found only in the seventh grade students who were exposed to SPI sentences (Vanevery & Rosenberg, 1970). The type of chunking used here was characterized as textual.

Carter, Hardy and Hardy (2001) investigated the effects of chunking and two information (imagery, processing) techniques on Latin vocabulary acquisition and memory retention. For this study textual chunking was employed. A total of 121 students enrolled in high school Latin I classes participated. Following a pretest, study participants were divided into four groups and provided a list of 21 Latin words to study. Comparison group A received the list of words grouped randomly into three groups of seven. Comparison groups B and C received the list of words categorized by related definition into three groups of seven. Comparison group C received five minutes imagery treatment prior to the immediate posttest. The control group X received neither a chunking technique nor an imagery treatment. Immediate and delayed posttests revealed that imagery and chunking instruction significantly improve students performance among high school Latin I students (Carter, Hardy, & Hardy, 2001).

Chunking of text significantly helps the learner to transform information from general to specific along with understanding relationships among given information. Chunking could help learners to learn more information by grouping it into digestible units. Facts and procedural concepts are more easily learned when an individual is taught how to apply chunking. For through chunking, information is transferred faster from short term to long-term memory. Further, chunked information is recalled more readily thereby assisting the formulation of even larger chunks the next time around. Finally chunking facilitates learners to progress more efficiently towards higher levels of learning.

In summary, chunking has been recognized as an important tool in learning because it helps to reduce information overload. Research has indicated how chunking enhances short-term memory and transfer from short-term to long-term memory. Miller's study on short-term memory indicated that memory capacity was limited at 7 ± 2 visual chunks. However this view is not universally accepted. Some have offered a small 3 - 5 chunks range. Others have suggested more than 24 chunks especially among expert chess players. Also the number of chunks seems to increase when there is an underlying meaning attached to the chunks themselves. This finding has a major implication in instruction, such that if students are presented with meaningful, relevant and well-organized information their capacity to retain is significantly increases.
The Chunking Theory was consolidated by Chase and Simon's studies on chess players following the EPAM theory. This theory was enhanced by Lane and others, as they applied their

CHREST computational model. But later theorists such as Holding offered the SEEK model as an alternative in an effort to explain how individuals absorb, store, recall and apply information. Whatever theory or model, all research studies have concluded that the design of chunks in instruction will help people increase their capacity to learn, retain, recall and apply information.

Animated Instruction

Animation has been used in instruction to assist one of the three functions: attention-gaining, presentation, and practice (Reiber, 1990). Reiber (1990) stated: “Although much research has been done of effects of non-static visuals (Dwyer 1978, for example), little research has been conducted on animation’s instructional effects. Empirical data that are available are inconsistent.” (p. 78).

Reiber (1990) summarized 12 studies spanning 1975 to 1989 which compared animation versus static visuals and the results were mixed. The studies summarized by Reiber: Caraballo’s (1985) study done with 109 adult subjects, the content area was computation of area of geometric shapes, animation used as an aid to conceptual understanding not as elaboration of lesson content, learning outcomes were facts, concepts and rules, the results showed no significance difference. Another study by Caraballo (1985) also used 109 adult subjects. Content was the physiology of the human heart. There was no validation done to determine if additional visuals were needed. Learning outcomes were facts, comprehension, and the results was no significance difference. Collins, Adams & Pew (1978) used 18 adults, content area was the geography of South Africa, learning outcomes were facts. Animation was used for attention gaining within as interactive dynamic. The results showed that interactive maps were more effective than labeled maps which in turn was more effective than unlabeled maps. King’s (1975) study used 45 adult subjects, content area mathematics, learning outcomes were rules and the learning task was not sufficiently difficult. The results showed no significant difference (Reiber, 1990). Moore, Nawrocki, & Simutis (1979) used 90 adult subjects on the psychophysiology of audition, learning outcomes were facts and rules, no significant differences were reported. It was confounding due to instructional design. Review was automatically given the students after each lesson part if achievement was less than 85 % thus producing a ceiling effect. Reed's (1985) study used 180 subjects on algebra word problems. The results were mixed according to word problem type. Rigney & Lutz (1975) used 40 adults on science, learning outcomes were facts, concepts and rules, the results showed that pictorial group was better that verbal (Reiber, 1990). As summarized in Reiber's article (1990) all these studies used different contents, different level of reliability and validity, animation was used for different purposes in each study, sample size was different, expected learning outcomes were also different. They never mentioned the types of animation, or placement of animation. That is why the studies showed mixed results. Rieber (1990) recommended three designs for the use of animated visuals in instructional materials: Animation should be used only when its attributes are needed in the instruction, it may be difficult for novice learners to attend to the cues and details provided by animation. Animations contribute to computer-based instruction by providing animation strategies that facilitate interaction between students and the instruction (Reiber, 1990).

Huk, Steinke and Floto (2003) studied effects of 2D and 3D animations. A pre-test was given to students to identify their prior knowledge before they were shown the animations. Animations were shown via video projectors to 188 biology students. The content was about bio molecule ATP-Synthase. Their findings included that students with high prior knowledge learned better with 2D animation whereas with students with low prior knowledge performed similar in both type of animation. They concluded that a plain two dimensional animation is therefore sufficient for understanding and reduces redundant information that otherwise leads to cognitive load and reduced learning success (Huk, Steinke, & Floto, 2003).

Dwyer and Dwyer (2003) reviewed five studies between 1991 and 2003 and presented at the International Visual Literacy Association Newport, RI. “Among 72 comparisons made in the five studies statistically significant results occurred only three times at the factual and conceptual level” (Dwyer and Dwyer, 2003, p. 4).

ChanLin (2000) investigated different instructional attributes provided by animation in facilitating descriptive and procedural learning. A total of three hundred-fifty students from eighth and ninth grade students participated in the study. They were assigned to different visual treatments on a class basis [text only (control group), graphics with text (T1), animation with text (T3)]. Each student also took a spatial ability test to determine spatial ability. ANCOVA was employed to examine their effects of these two factors. The results indicated that use of animation promoted descriptive learning among those with high spatial abilities, while using graphics promoted learning among those with low spatial abilities (ChanLin, 2000).

Chan and Black (2005) conducted a study to evaluate the efficacy of static visuals, system- controlled animation and direct-manipulation animation on comprehension, memory recall and transfer. Thirty-two seventh graders participated in the study. The design was a three group (static visuals, system controlled animation and direct manipulation animation) post-test only design. Dependent measures (written recall, system drawing and problem solving tasks) were used to assess how the participants learned about the energy conversion in a roller coaster ride. All participants were given 15 minutes to read a 600-word summary describing how energy is transferred during a roller coaster ride after the completions of a survey on their knowledge of the topic. Then they were randomly assigned to one of three treatment conditions: static visuals (SV; control), system-controlled animation (SCA), and direct-manipulation animation (DMA). All the participants were allowed five minutes to view or interact with the visuals. The SV group viewed a sequence of seven static snapshots representing the critical steps in energy conversion during a roller coaster ride. The SCA group was seated at an IBM ThinkPad, on which they viewed or interacted with a computer animation in continuous motion. The DMA group used a direct-manipulation version of the animation to explore the topic. Next, all participants were asked to write a summary of energy conversion during a roller coaster ride. Then, they drew diagrams to illustrate the energy conversion processes. Finally, they were given three problem-solving tasks on flawed roller coaster designs. The results were that participants in the static visuals and direct-manipulation animation groups were able to recall more pertinent idea units and depicted more relevant phases in their drawings than those in the system-controlled animation groups. As for transfer, the results indicated that participants in the direct-manipulation animation group performed better than their counterparts. However, the three groups did not demonstrate any significant difference in their performance on problem-solving tasks. Their findings suggested that it was important to allocate sufficient time for learners to process the information and parsing salient thematic information for comprehension and mental model construction. Direct manipulation animation was more effective than static visuals and system-controlled animation in helping learners to connect visual representation with system dynamics in their process of understanding the functional relations of a dynamic system (Chan, Black, 2005).

Graphics have been used for a very long time because they provide an additional way of presenting information. Because they may be aesthetically appealing, and sometimes humorous, they tend to attract attention and maintain motivation. Additionally graphics have been assumed to facilitate comprehension, learning, memory, communication and inference (Tversky, Morrison, & Betrancourt, 2002). Their cognitive usefulness hinges upon the Congruence Principle, where the structure and content of the external representation (such as a physical the entity) must correspond to the desires structure and content of the internal (graphic) representation.

Through advances in technology, graphics have evolved into a more attractive device of animation. This has greatly facilitated effective representation of processes which could not be properly represented by static visuals. This phenomenon, in turn, has attracted the attention of educators who choose to augment their instructional interactivity with animation. A review of the literature on research studies conducted about animation has been inconclusive. Tversky, et al (2002) found that in many studies the information presented in animation was not equivalent to that presented in static graphics. As a result the relative effectiveness of animated over static graphics was masked by other confounding variables not properly controlled (Baek and Layne, 1988; Tversky, et al, 2002).

Feedback

Feedback is an essential construct form from many theories of learning and instruction. Providing feedback to students can make a significant difference in their achievement (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991). Learning outcomes of feedback includes identifying errors, becoming aware of misconceptions and motivating for further learning. Computer based instruction (CBI) has the ability to provide feedback on individual responses. Computer-provided feedback has several important advantages: computers can tirelessly provide feedback in response to student work, unlike feedback from an instructor. This feedback remains unbiased, accurate, and nonjudgmental. In addition the interactive nature of computer-based instruction has the potential for enhancing quality and type of feedback that can be implemented (Mason & Bruning, 2001).

Buzhardt and Semb (2002) compared three types of feedback: feedback after each item in invariant sequence (IBI/i), feedback after each item in any sequence determined by the students (IBI/a), feedback provided at the end of the test (EOT). Students who received item-by-item feedback with the skip option performed the same as students who received end-of-test feedback on the unit quizzes and final exam. However the teaching staff spent significantly less time answering questions when students received item-by-item feedback with the skip option than when they received end-of-test feedback. Sixty-five percent of the students preferred item-by-item feedback with the skip option. The authors concluded that item-by-item feedback with the skip option decreases the workload on teaching staff without sacrificing performance and students liked it more than the other types of feedback (Buzhardt & Semb, 2002).

Moreno and Valdez (2005) examined the role of dual coding and interactivity in promoting scientific understanding consistent with a cognitive theory of multimedia learning. Findings concluded that students learn better when provided with visual and verbal knowledge representations rather than visual or verbal representations alone. On the contrary, having students organize the multimedia materials was detrimental to transfer. Two follow-up experiments tested the negative effects of interactivity if they were due to students' lack of time, control and the form of feedback. The findings showed interactivity was effective when students were asked to evaluate their answers before receiving corrective feedback from the system. When students are given a cognitively engaging task - the interactive treatment - and control over the pace of their interaction deep learning is not promoted unless careful consideration is given to the effects of different feedback strategies.

In this study, researchers investigated the effects of receiving the preferred form of online assessment feedback upon middle school mathematics students. Fifty-two high school students who completed an online mathematics learning module and quiz system were first asked whether they preferred to receive performance feedback that compares them to other people (norm-referenced or competitive) or to their own past attempt (self-referenced or individualistic). Students then worked through an online quadratic equations learning module followed by a randomly generated and timed online quiz that they could practice as often as they chose. Results indicated providing students with their non-preferred form of feedback had a significantly negative impact on their mathematics ability self-rating, and also the facility to practice led to a significant improvement in test scores (Bower, 2005).

Pashler, Cepeda, Wixted, and Rohrer (2005) compared immediate, delayed feedback and correct/incorrect condition. Their findings were that correct/incorrect condition feedback makes a little difference for what can be remembered a week later. Whenever subjects make an error providing feedback and time to process the feedback makes a difference.

Kulik and Kulik (1988) reviewed 53 research studies comparing the effects of immediate and delayed feedback. The variables used to describe the studies were: study type, timing of immediate feedback, timing of delayed feedback, number of different tests or list to be learned, number of trials or times each test was taken, outcome measure, subject assignment, stimulus exposure, duration of treatment, class level, year of the report, source of the study. The studies consisted of three sorts of learning situations: quiz instrument, acquisition of test content, memorization of list. Fourteen reports contained results from the measures of immediate learning. Eight reports contained results from the follow-up measures. Thirteen studies were on students who received immediate feedback performed more poorly than those who received delayed feedback. Only one study reported that students did better with immediate feedback. Students learned the content of a multiple-choice test when they received immediate feedback. The follow up test consisted of original measures of learning. In 16 of the 27 studies with experiments on list learning there was reported superior performance with immediate feedback. Eleven studies reported better list learning with delayed feedback. Kulik and Kulik theorized that immediate feedback was actually most effective in all situations and the artificial environment of the acquisition of test content and memorization of list experiments influenced which feedback appeared most effective, since they resembled other experiments comparing massed versus distributed learning (Kulik & Kulik, 1988).

Clariana, Wagner, and Roher-Murphy (2000) compared delayed feedback (DF), single try immediate feedback (STF), multiple try immediate feedback (MTF). Fifty-two high school students took computer-based lesson materials consisting of eight reading passages and 36 multiple choice questions from Nelson Danny Reading. It was confirmed that retention of initial lesson responses is greater for delayed feedback compared to immediate feedback across all item difficulties but especially with difficult lesson items, feedback has its greatest effect with difficult lesson items and there was no disordinal interaction of feedback timing and item difficulty (Clariana, Wagner, & Roher-Murphy, 2000).

Dempsey, Driscoll, and Litchfield (1993) examined the effects of four methods of immediate corrective feedback (knowledge of correct response only KCR, knowledge of correct response and forced correct response KCR + Forced CR, knowledge of correct response and anticipated wrong answer remediation KCR + AWA, knowledge of correct response and a second try to respond to the item KCR + Second try). There were no differences in retention among the four feedback conditions. However simple KCR was more efficient followed by KCR + AWA group, and KCR + Forced CR and KCR+ second try group (Dempsey, Driscoll, & Litchfield, 1993).

Bangert-Drowns, Kulik, Kulik, and Morgan (1991) reviewed 58 effect sized reports. This review concentrated on the effects of mediated feedback aimed at improving information. Findings indicated that feedback does not always increase achievement and in fact, is sometimes associated with decrements in achievement. A full third of the 58 findings were negative. Type of feedback was also related to the effect size. When feedback indicated that a response was correct or incorrect, it resulted in a lower effect than when the feedback in some way informed the learner of the correct answer. In tests like events, feedback's primary importance was in correcting errors. There was significantly large positive correlation between error rate and effect size again showing that as students make more errors during instruction. Feedback has a more important effect on later retrieval of correct information. Use of pretest significantly lowered effect sizes. This suggests that the pretests influence learner expectancies, review content, give practice in test item formats, or otherwise serve as primitive advance organizers for the instruction to follow. Feedback effects could be differentiated according to the type of instruction in which the feedback was used. Feedback in programmed and computer-based instruction was less effective than in text comprehension and conventional testing situations. It would seem that feedback is more important when the content is more complex and when the student is given fewer cues, organizers and other instructional supports. Feedback is most effective under conditions that encourage learners' mindful reception (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991).

Mason and Bruning's (2001) paper summarizes and analyzes recent research in computer-based feedback. Feedback can take different forms. Eight commonly used levels of feedback are: No feedback, Knowledge of response, answer until correct, knowledge of correct response, topic contingent, response contingent, bug related, attribute isolation. Research seeking to find out which type of feedback is most effective has mixed results. But it has identified several key dimensions such as elaboration, student achievement levels, depth of understanding, attitude toward feedback, learner control, response certitude and timing (Mason, and Bruning, 2001).

Providing elaborative feedback within a CBI unit did not influence students' knowledge of the material (Clark, 1993; Hodes, 1984-1985; Merril, 1987; Mory, 1994; Park & Gittelman, 1992). Some other studies found that elaborative feedback enhanced learning. (Clariana, 1990, 1992; Gilma 1969; Pridemore & Klein 1991, 1995; Morrison et al., 1995; Roper, 1977; Waldrop, Justen, & Adams, 1986; Whyte, et al, 1995). Low achieving or low mastery students may benefit from more immediate feedback while high achievers better utilize delayed feedback. Also low ability students benefited more from knowledge of correct response than answer until correct feedback (Gaynor 1981, Roper 1977, Clariana 1990). Primedore & Clein (1991, 1995) has found that students' attitude toward feedback does not impact learning outcomes and revealed a desire by students to receive more elaborative-immediate feedback. Waddick (1994) found increased mastery of the material and positive views from the students. When the certitude is low regardless of the correctness of the answer learners spend little time on feedback. When the answer is correct and high certitude learners also spend little time on feedback (Kulhavy, Yekovich, & Dyer, 1976; Kulhavy, 1977). Mory (1994) found differently that feedback times for low certitude responses were significantly higher than feedback study times for high certitude errors (Mason & Bruning, 2001).

The findings on feedback in CBI indicate that there is no best-type feedback in computer based instruction for learners and learning outcome. There are several factors to consider when designing feedback for CBI such as prior knowledge, student achievement levels, nature of the learning task. It is also important to make a decision on the amount of learner control, attitudes toward feedback, and demands for efficiency (Mason and Bruning, 2001).

Gaming

Playing games is an important part of our social and mental development. Understanding the relationship between educational needs and game elements will allow us to develop educational games that include visualization and problem solving skills. Such tools could provide sufficient stimulation to engage learners in knowledge discovery while at the same time developing new skills (Amory, Naicker, Vincent, & Adams, 1999).

Amory, Naicker, Vincent, and Adams (1999) investigated what type of games were more appropriate for learning environments and tried to identify game elements that student found interesting or useful within the different game types. Their findings concluded that students favored 3D-Adventure and strategy games to simulation games. Students also identified graphics, sound, story line as important aspects and perceived skills such as visualization, logic, memory as important skills required to play adventure games (Amory, Naicker, Vincent, & Adams, 1999).

Simpson (2005) argues that compared to the classroom, games are empowering, motivating and provide individualized learning environments with sets of rules which value the efforts of the individual child. Games are challenging and motivating. They offer children a shared experience with their peers in collaborative environment. They are a platform for problem solving. The structure is apparent, rules are clear, and the student's role in the games is well defined. The authors emphasize that schools should realize and work to enhance the learning capabilities of gaming.

McEacharn (2005) investigated the effects of a game used in a senior level-auditing course for several years. Examination scores and graduating senior exit examination scores were analyzed along with a questionnaire about the game effectiveness. The game was called "who wants to be" (WWTB) based on the television game show "Who Wants to be a Millionaire?" His finding included an increase in the mean score for the first examination from 76 % to 79% during the time the game was used and the increase was statistically significant. The second examination showed an improvement in the mean scores from 76.8% to 80.8% and statistically significant. The third examination did not show any increase. Overall the students' mean scores in the course improved from 81.1% to 82.1%. The average audit score with a maximum score of 15 possible increased from 10.9 to 11.4 for the period when the game was used in the audit class. A questionnaire was used to obtain feedback from the student about WWTB. The results indicated that students found WWTB a useful learning tool.

Whelan (2005) explained the Quest Atlantis game and its effectiveness. Quest Atlantis is a software tool that blends education, entertainment, and social responsibilities. The game has chat rooms and e-mail capabilities create a strong sense of community and accompanying posters, comic books and trading cards to make it more exciting for the kids. A research team from Indiana University created Quest Atlantis and studied thousands of Questers and their teacher for more than two years. The research team conclusively said that the game was engaging, meaningful, and educational. Game playing offered students more insights than those who did not play when they are asked to elaborate on their readings. The game players empathized more deeply in some language-art work and wrote richer explanations of a situation in a science unit. The participants showed significant learning over time in their understanding of life processes. Students also found the game more enjoyable than any learning activity in their life (Whelan, 2005).

Dempsey, Lucassen, Haynes, and Casey (1996) investigated what are the design expectation of learners from a game. They used 40 different computer games played by 40 adult subjects (20 male, 20 female). They found that players wanted clear and concise instructions, challenging games, control over gaming options as speed, difficulty, timing, and help functions. They also included screen design, color action, appropriate use of sound and feedback. The players also desired increased game design factors (Dempsey, Lucassen, Haynes, & Casey, 1996).

Dempsey, Lucassen, and Rasmussen (1996) reviewed 99 articles dealing with different aspects of gaming. They acknowledged that there is great potential for gaming to enrich certain educational and training activities. They cited Faria's (1987) report that 4600 of the larger U.S. firms surveyed used business or experimental games in training and development. Other research findings seem to suggest a wide range of educational benefits such as practical reasoning (Wood & Steward, 1987), higher levels of motivation (Malouf, 1988), and reduced training time and instructor load (Allen, Chatelier, Clark, & Sorenson, 1982). They identified five different categories of articles on gaming: research, theory, reviews, discussion and development, with the majority focusing on discussion and research. In a large number of the articles concerning games or gaming (n = 45), the prevailing learning outcome focus of the studies was problem solving. They also found a preponderance of the intent to promote higher-level intellectual skills and attitude learning as opposed to verbal knowledge outcomes. They found this "as a positive testimonial to the gaming mode." (Dempsey, Lucassen, & Rasmussen, 1996).

Huang and Cappel (2005) assessed the usage of an online game in an information system course. The online game consisted of three components: a web page, a game shell, and a test file contained of questions about the materials from the chapter in the course textbook. It was available to all students about the same time the chapter was covered in the course. Use of the game was voluntary and no extra credit was given to the students for playing the game. Their finding concluded that the game helped students test their understanding of material and identify topics to study in more detail, it clarified expectations about the type of topics or questions that could be on the exam, and made learning more fun and interesting. They concluded that most students would take advantage of the games if the instructors make these games available to them (Huang & Cappel, 2005).

Cameron and Dwyer (2005) examined the effect of gaming, gaming with questions, gaming with questions and feedback on delayed retention of different educational objectives for field dependent and field independent students. Four hundred and twenty two students participated in this study. First they took a Group Embedded Test to separate them into field dependent and field independent learners. Second they were randomly assigned four treatments (T1 instructional unit with no instructional game, T2 instructional unit with instructional game, T3 instructional unit with instructional game and knowledge of correct response feedback, T4 instructional unit with instructional game and elaborative feedback) and received instructional presentations. The content used in the instructional unit was parts and functions of human heart. The game created by Cameron was called the heart attack game. In the game students attempted to save a patient in fifteen minutes by correctly answering questions about the human heart and its function. Third, two weeks after presentations, the participants took four criterion tests (drawing, identification, terminology and comprehension) measuring different educational objectives. The results of this study suggested that gaming was an important instructional strategy to retain information for specific types of educational objectives. When feedback was included in the game statistically significant differences occurred in achievement in all criterion measures. However the instructional game with elaborative feedback was more effective in facilitating achievement on all criterion measures. Instructional game with knowledge of correct response was found more effective on achievement terminology criterion measures. These findings suggested that treatments using game with feedback provided a level of rehearsal opportunities for learners to be able to move information into long-term memory for delayed retention. Participants who were identified as field independent learners achieved significantly higher scores on all criterion measures than the participants who were identified as field dependent learners. In summary, this study indicated that the use of games was effective in facilitating student achievement when the games were presented with elaborative feedback (Cameron & Dwyer, 2005).

In summary, games have been used extensively in education, and have the potential of benefiting both learners and teachers. They are particularly beneficial when higher-level problem solving activities are to be learned.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

Selection of Instructional Units

The instructional module selected for use in this study developed by Dwyer (1972) focused on the physiology and functions of the human heart. The lessons included facts, concepts and rules, and procedural information covering the parts of the heart, circulation of blood cycle, and blood pressure during the diastolic and systolic phases of the heart (Dwyer, 1978). The instructional modules were created following the Instructional Consistency-Congruency Matrix, which ensured that learning activities in the instructional modules were directly focused on dependent measures (Dwyer, 1994). This content was selected because it provided a hierarchy of learning objectives ranging from facts to problem solving.

A web-based self-paced programmed instructional unit was designed and developed to use in this study, based on the pilot studies done by a research team (Lin, Kidwai, Munyofu, Swain, Ausman, & Dwyer, 2005). Programmed instruction was selected because its use generated time-saving for students. It was also as effective as the conventional instruction in immediate learning and retention (Nash, Muczyk, & Vettori, 1971). The entire web-based instructional unit is provided in Appendix A.

Pilot #1: Item Analysis #1.

Programmed instruction, created by a research team, was based on Dwyer's instructional heart content module (Dwyer, 1978). Programmed instruction had two sections. In the first section the instruction contained 17 instructional frames about the physiology of the heart, six frames for feedback to learners presented with multiple choice questions, and answers to those questions. The programmed instructional segment was designed to ensure that learners would achieve competency at the factual and simple concept levels. These “knowledges” were considered to be prerequisite to achieving different types of learning outcomes. The second part had ten instructional frames about the cycle of blood flow during systolic and diastolic phases. The first pilot study was conducted on the programmed instruction to identify where static visuals would not function properly, so that animation could be properly positioned. The participants were 12 undergraduate students who were not previously exposed to the instructional unit. The instructional units were followed by four twenty-item tests on drawing, identification, terminology and comprehension. The total mean for the drawing test was 14.92 with a standard deviation of 4.42. For the identification test the total mean was 18.00 with a standard deviation of 2.26. The terminology test had a total mean of 12.50 with a standard deviation of 4.36. The comprehension test total mean was 12.83 with a standard deviation of 3.93. Test items with .60 difficulty index were considered to be the items where the animation could be effectively used to increase the effectiveness of the instruction and learner achievement. There were 25 of the 80 items that had an item difficulty below .60 (Lin, et al, 2005). This item difficulty index refers to the percent of individuals tested who answer a particular item correctly. An instructional designer’s role is to help people learn better. As instructional designers our expectation is to help learners to accomplish 100% learning. Therefore the research team identified items with difficulty below .60 as those to be enhanced.

Pilot #2: Item Analysis #2.

Computer animation was created to complement the static visualization in the 25 different areas that were identified in item analysis #1. There were ten animated web frames. Then the animated programmed instruction was piloted. Forty-seven participants took only the programmed instruction and 44 students got programmed instruction + simple animation. The total scores for the first group (programmed instruction only) were as follows: for the drawing test the mean was 15.80 with a standard deviation of 4.48; for the identification test the total mean was 17.55 with a standard deviation of 2.08; for the terminology test the total mean was 12.70 with a standard deviation of 4.12; and for the comprehension test total mean was 11.23 with a standard deviation of 3.66. The total mean scores for the second group (programmed instruction + animation) were as follows: the drawing test was 14.95 with a standard deviation of 4.24. For the identification test the total mean was 17.25 with a standard deviation of 2.62. The terminology test had a total mean of 11.80 with a standard deviation of 3.98. The comprehension test total mean was 10.80 with a standard deviation of 3.99.

The results for this pilot indicated that animation did not make any significant difference on learners' performance. Twenty-four items remained below the .60 difficulty level (Lin et al, 2005).

Pilot #3:

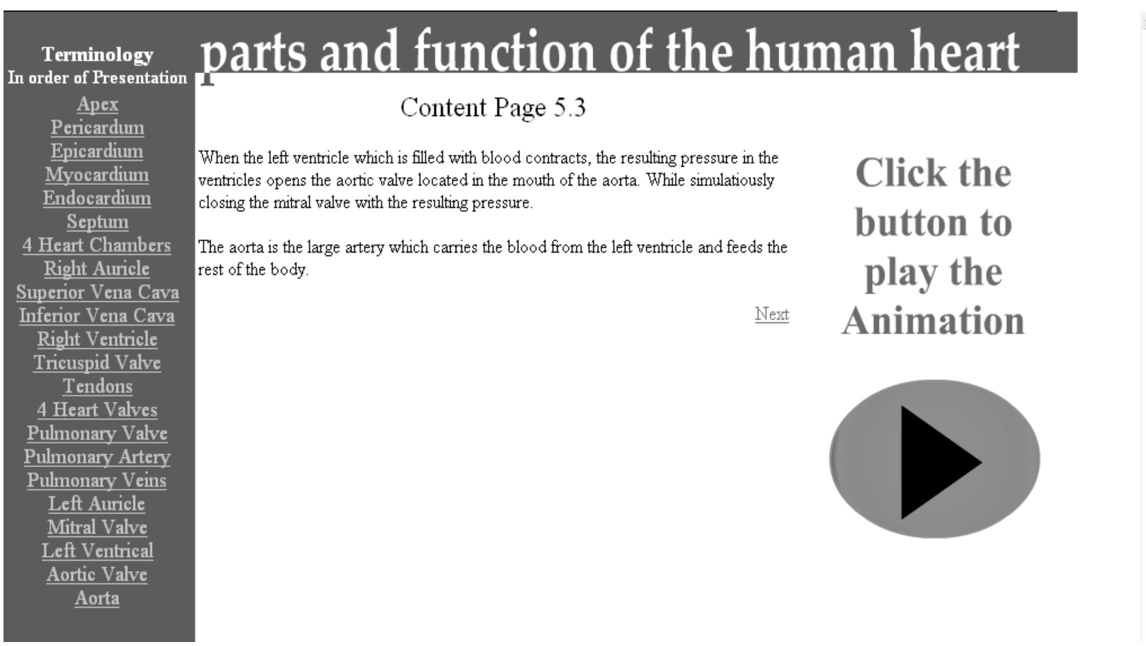
Based on item analysis the research team decided to address 24 items (Lin et al, 2005): 5 items in the drawing, 9 items in the terminology and 10 items in the comprehension tests. The focus was on terminology and comprehension tests had been developed to measure student achievement of different types of learning objectives (concepts, rules/principles and comprehension). This researcher designed two additional treatments. Treatment #1, animated programmed instruction was the control group. Treatment #2 employed simple visual/text chunked information to help learners to concentrate on important information which was presented on the animated sequence. Treatment #3 employed complex visual/text chunked information to complement animated instruction. Analysis of variance conducted on mean achievement scores among treatments indicated that significant differences existed on the Terminology $F(2, 84) = 3.88$, $p < .05$; and Comprehension Tests $F(2, 84) = 3.24$, $p < .05$. Insignificant differences in achievement were found to exist on the Drawing Test $F(2, 84) = .167$, $p > .05$; Identification Test $F(2, 84) = .330$, $p > .05$ and Total Test $F(2, 84) = 1.39$, $p > .05$. Follow-up analyses (Dunnett C) indicated that Treatment 3 (programmed instruction with complex visual/text) was significantly more effective than the control treatment on the Terminology and Comprehension tests at the .05 level. Scheffe's follow-up analysis indicated that treatment # 3 was more effective than treatment # 1 on both Terminology and Comprehension tests at the .05 level (Munyofu, Swain, Ausman, Lin, Kidwai, & Dwyer, 2007).

Table 1. Means and standard deviations for students in Each Treatment on Each Criterion Measure

	Program Instruction with Animation Control Treatment # 1 (N = 29)		Program Instruction with Simple Visual-Text Animated Instruction Treatment#2 (N = 29)		Program Instruction with Complex Visual-Text Animated Instruction Treatment#3 (N = 27)	
Tests	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Drawing	15.97	3.16	16.28	3.51	16.52	4.08
Identification	17.34	2.95	17.62	2.19	17.89	2.27
Terminology	11.48	4.87	12.72	3.66	14.52	3.57
Comprehension	10.75	3.49	12.21	3.73	13.26	3.87
Total	44.07	7.34	46.10	7.83	47.67	9.12

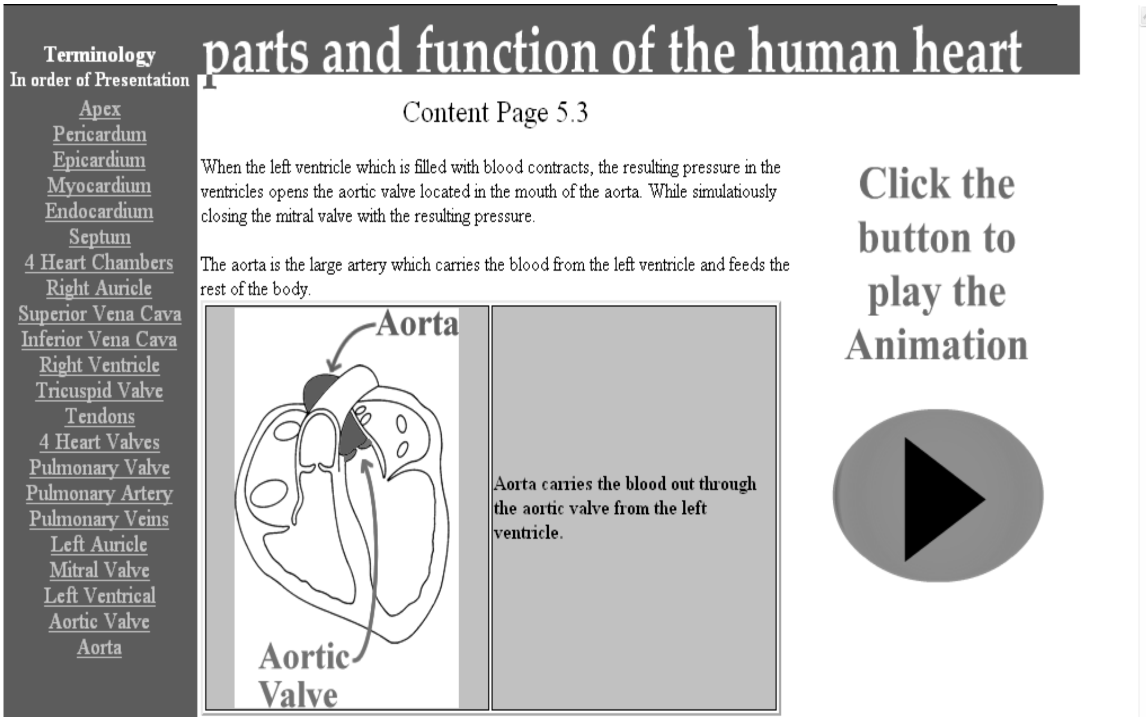
Adapted from " The effect of different chunking strategies in complementing animated instruction" by M. Munyofu, W. J. Swain, B. D. Ausman, H. Lin, K. Kidwai, F. Dwyer, 2007, *Learning Media and Technology*, 32, p. 416.

Figure 1. Sample Frame: Programmed Instruction with Animation



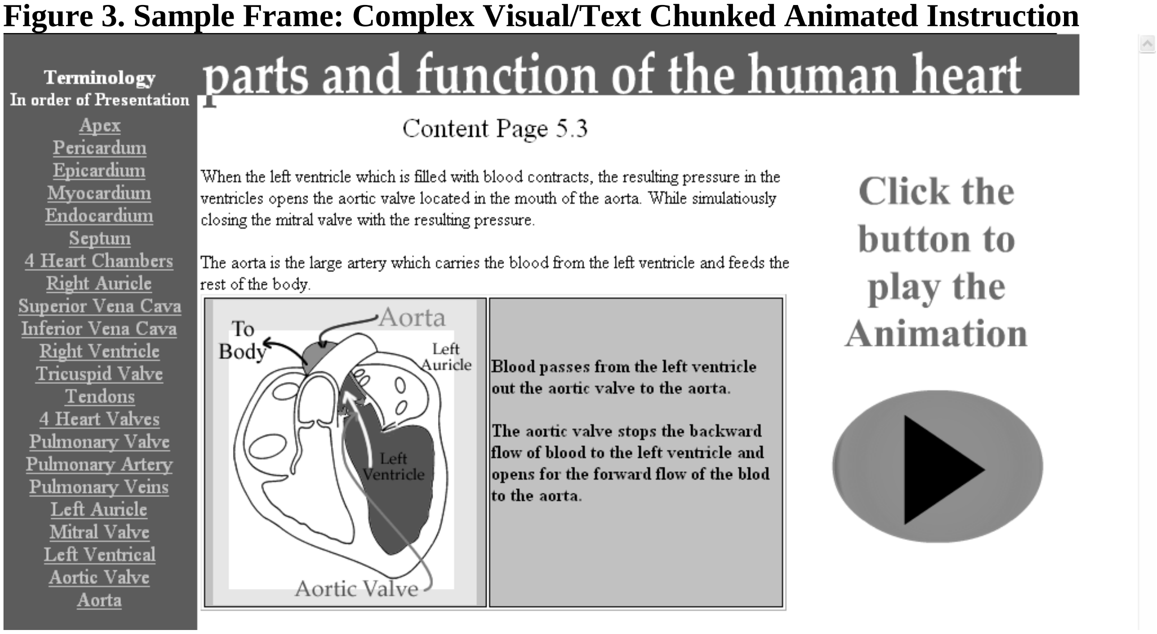
Adapted from " The effect of different chunking strategies in complementing animated instruction" by M. Munyofu, W. J. Swain, B. D. Ausman, H. Lin, K. Kidwai, F. Dwyer, 2007, *Learning Media and Technology*, 32(4), p. 413.

Figure 2. Sample Frame: Simple Visual/Text Chunked Animated Instruction



Adapted from " The effect of different chunking strategies in complementing animated instruction" by M. Munyofu, W. J. Swain, B. D. Ausman, H. Lin, K. Kidwai, F. Dwyer, 2007, *Learning Media and Technology*, 32(4), p. 414.

Figure 3. Sample Frame: Complex Visual/Text Chunked Animated Instruction



Adapted from " The effect of different chunking strategies in complementing animated instruction" by M. Munyofu, W. J. Swain, B. D. Ausman, H. Lin, K. Kidwai, F. Dwyer, 2007, *Learning Media and Technology*, 32(4), p. 414.

Description of New Presentation Materials

Based on these pilot studies, to accommodate the need of this study, some minor modifications and further development of the presentation materials were required.

Animation

All animations in this study were created with Macro-media Flash application. The movements were zoom-in, zoom-out, blinking, opening and closing of valves with blood flowing down and up. All locations would be shown with blinking arrows originating at the location names. Participants clicked on an animation button and watched the animation. The participants could watch the animation as many times as they needed. There were eight animated frames in this study. There were ten animated frames in pilot # 2 and pilot # 3. Two frames in pilot # 2, 3 had small segments of information in the functions of the heart. Those two frames were combined into one animation to show continuation of the process. Seven of the eight animations were placed on the right side of the instructional frames. Following figures are examples of how the animations were placed in the instructional unit. The shortest animation took 8 seconds and the longest took 24 seconds.

Figure 4. Animation button of the instructional unit

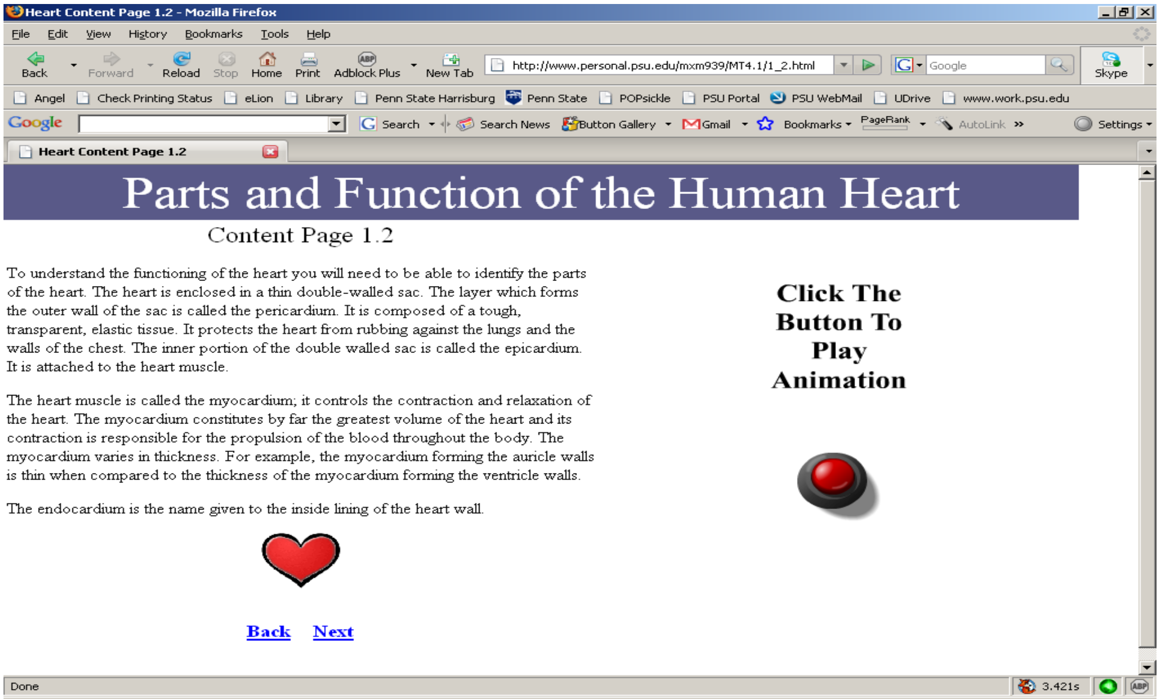


Figure 5. Animation playing

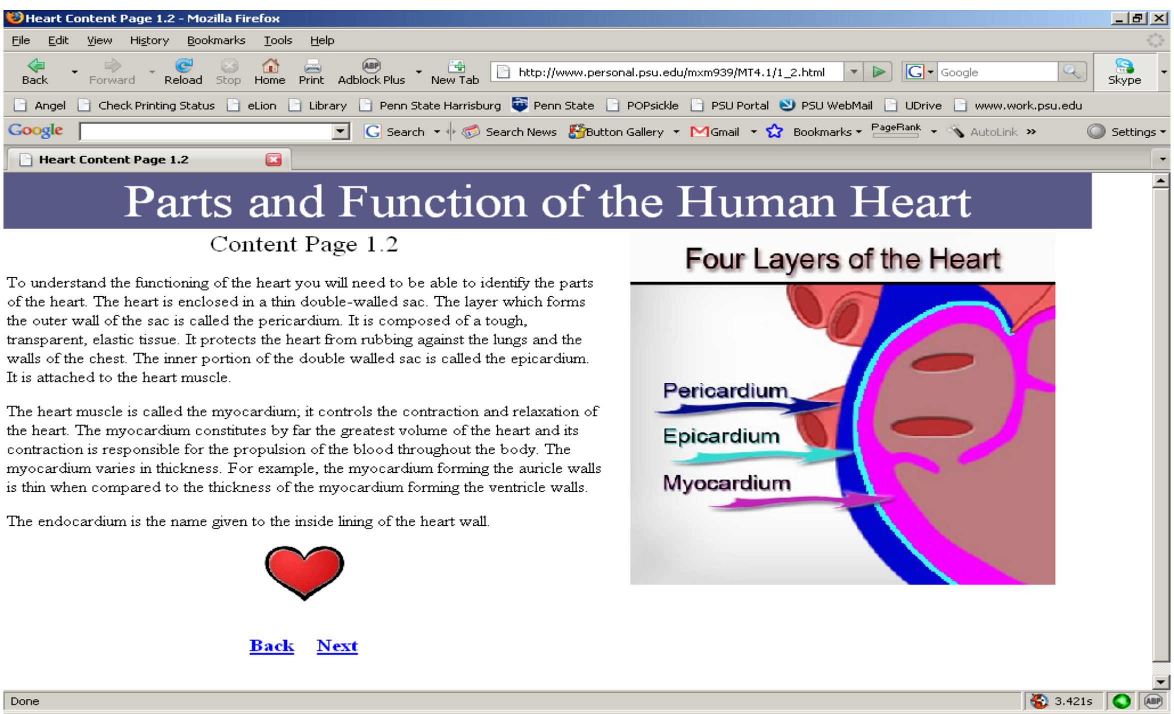
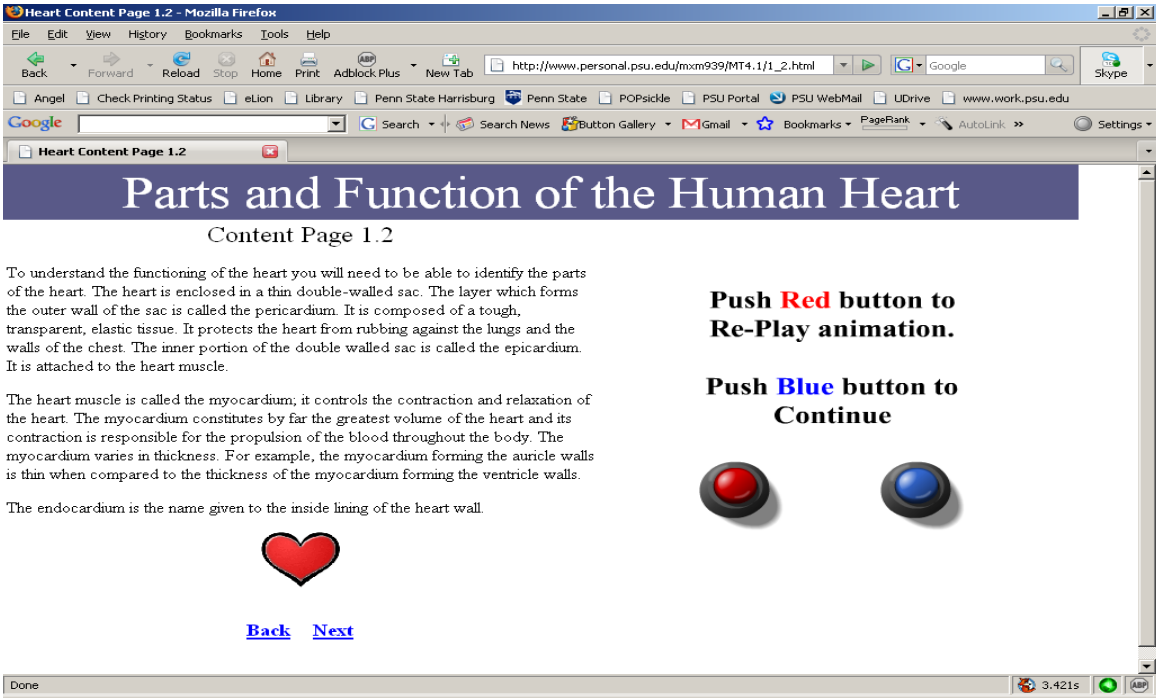


Figure 6. Animation buttons after played one time



Chunking

Chunking strategies were presented as links to little animated heart symbols to increase interactivity and curiosity. Chunked information was presented on the same frame with the instruction. Learners went through instructions, then clicked on the little heart symbol which was linked to chunked information. After they read and looked at the visual/text chunked information they could close the page by clicking on the close button. There were 12 simple visual/text chunked frames and 12 complex visual/text chunked frames. However there were 14 cells of simple visual/text chunked information and 13 cells of complex visual/text chunked information. The reason for the number of cell differences related to the way simple and complex chunks are defined. Simple visual/text chunks explain only one topic in the content area while complex visual/text chunks explain associated parts and functions in the content area. The following figures are examples of simple and complex visual/text chunked information. All simple visual/text and complex visual/text chunked frames are presented in Appendix C.

Figure 7: An example of chunked frame

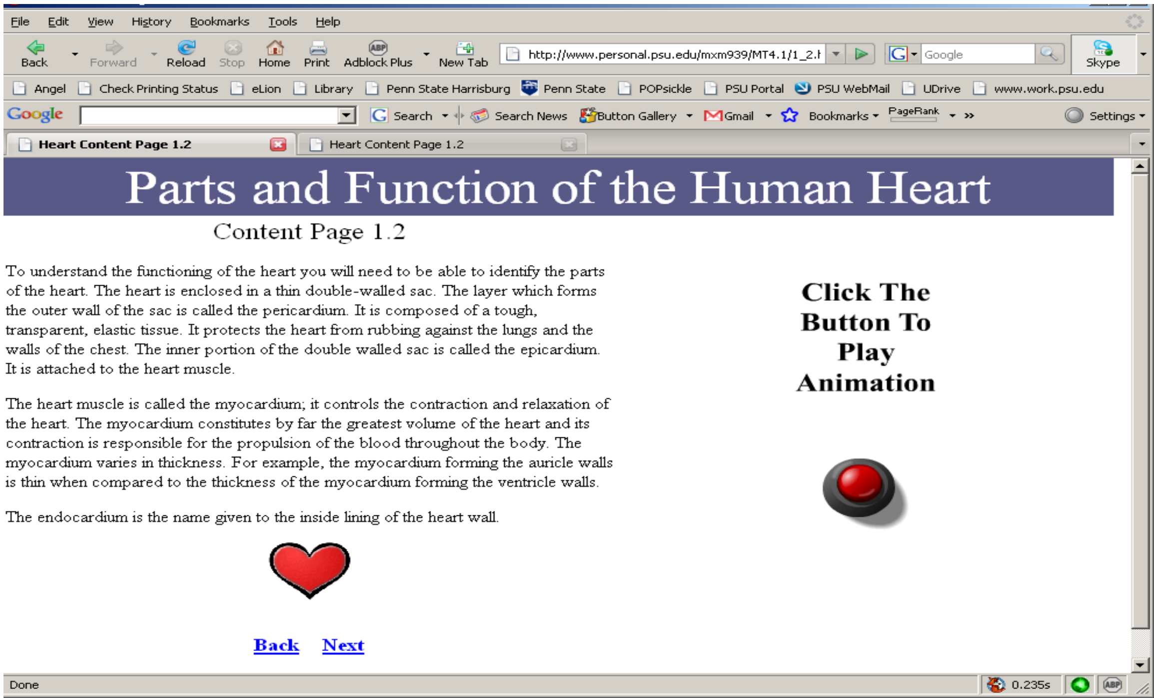


Figure 8: An example of simple visual/text chunked frame

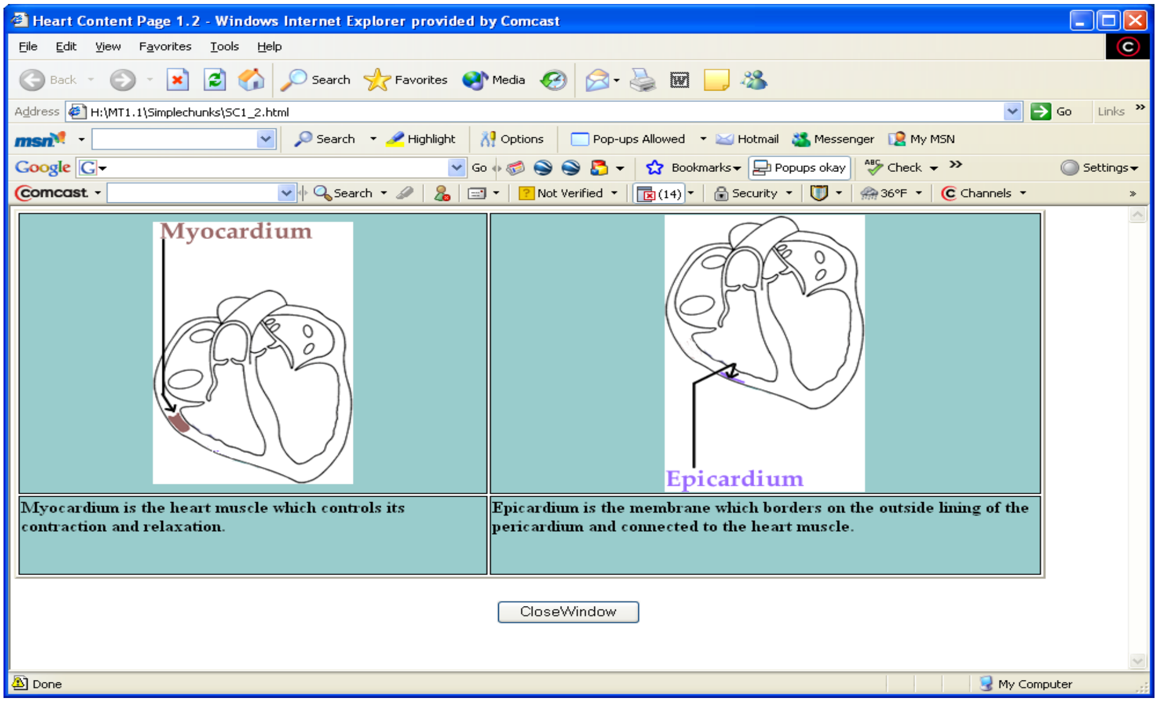
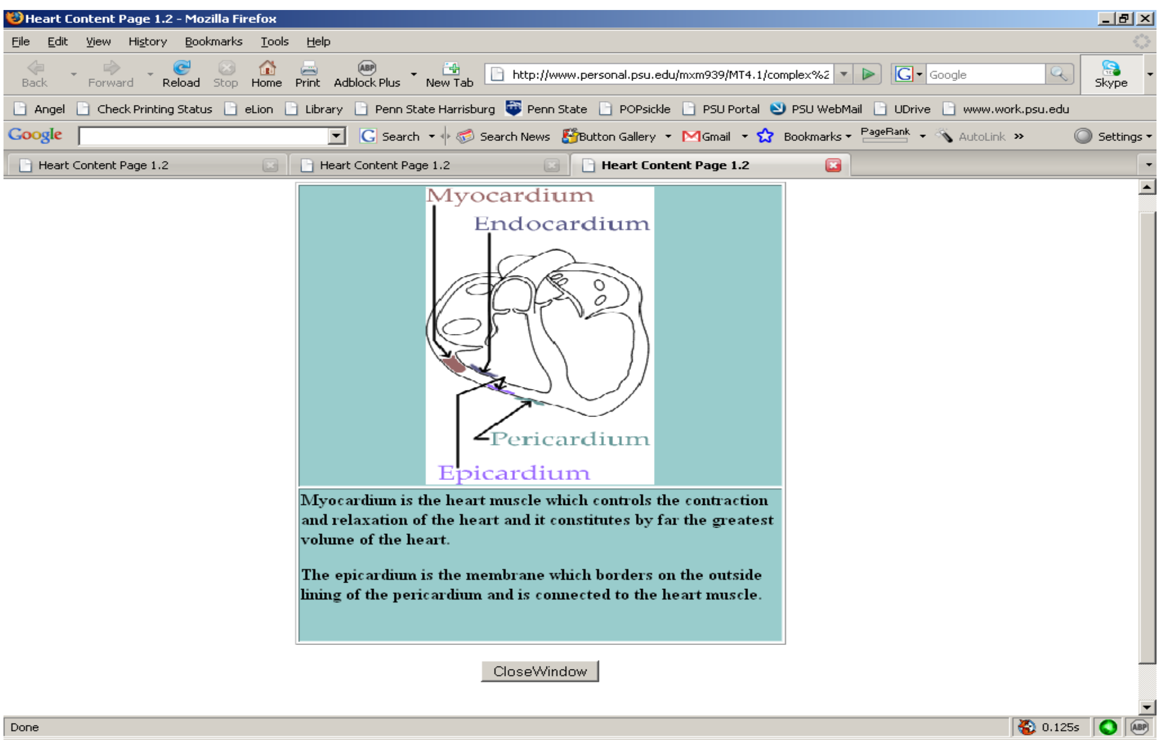


Figure 9: An example of complex visual/text chunked frame



Feedback

Feedback was given on four practice test frames, each including seven questions. The first three frames were on the first section of the programmed instruction, which was about parts of the human heart. The fourth frame was given in the second part of the programmed instruction, which was about the functioning of the human heart. This section had ten instructional frames. The practice frame was after the fifth instructional frame. The reason for this placement was to give feedback and avoid having to give redundant information at the end of the instruction. Right after the second part of the programmed instructional units, the participants played the game which covered questions from the three tests (Identification, Terminology, Comprehension). If the treatment type was item-by-item feedback treatment, the participants got feedback right after each question answered on a practice test frame. If the treatment type was end-of-test, the participants got the same feedback cumulatively for all questions at the end of the practice test. If the treatment type was no feedback, at the end of the test participants were informed about the number of correct answers out of the maximum possible number of correct answers. All feedback frames are presented in Appendix C.

Figure 10. Example Item-by-item feedback frame

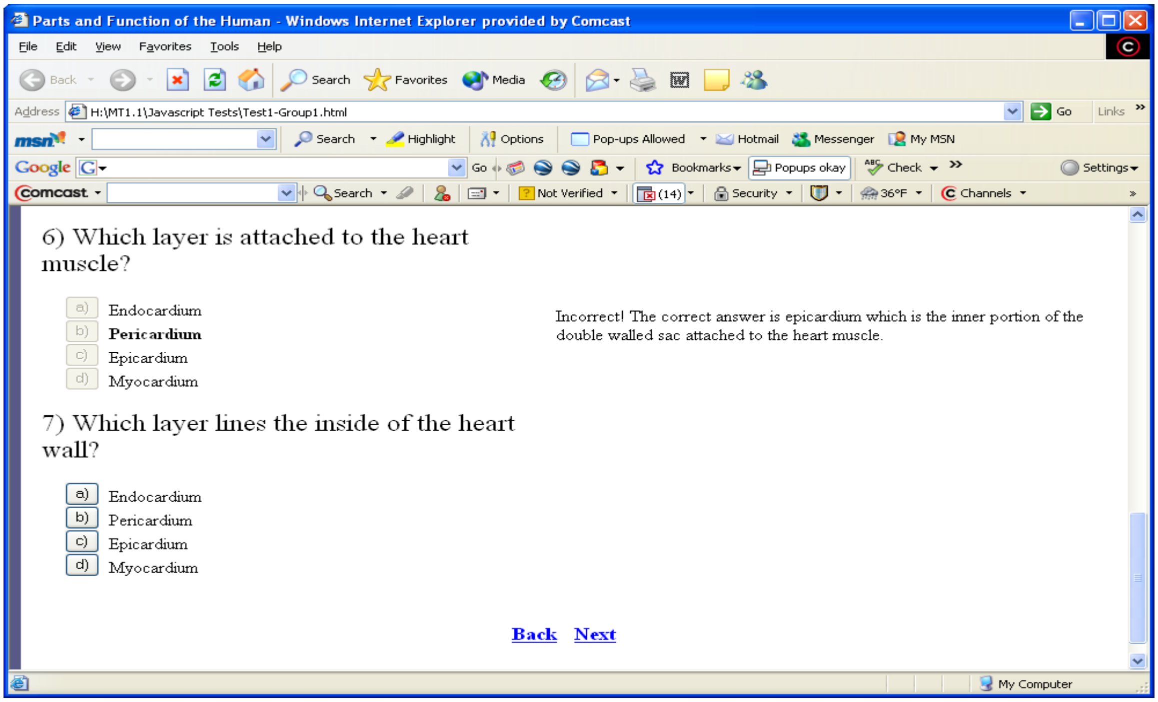


Figure 11. Example End-of-test frame

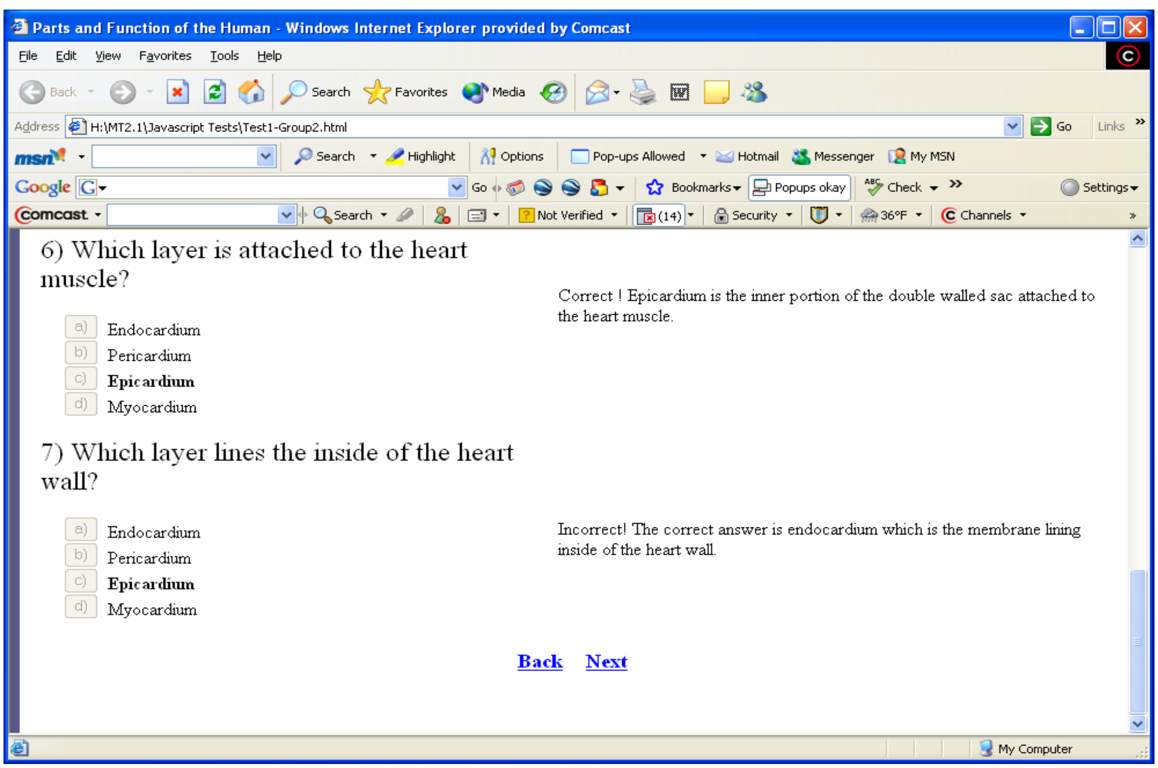
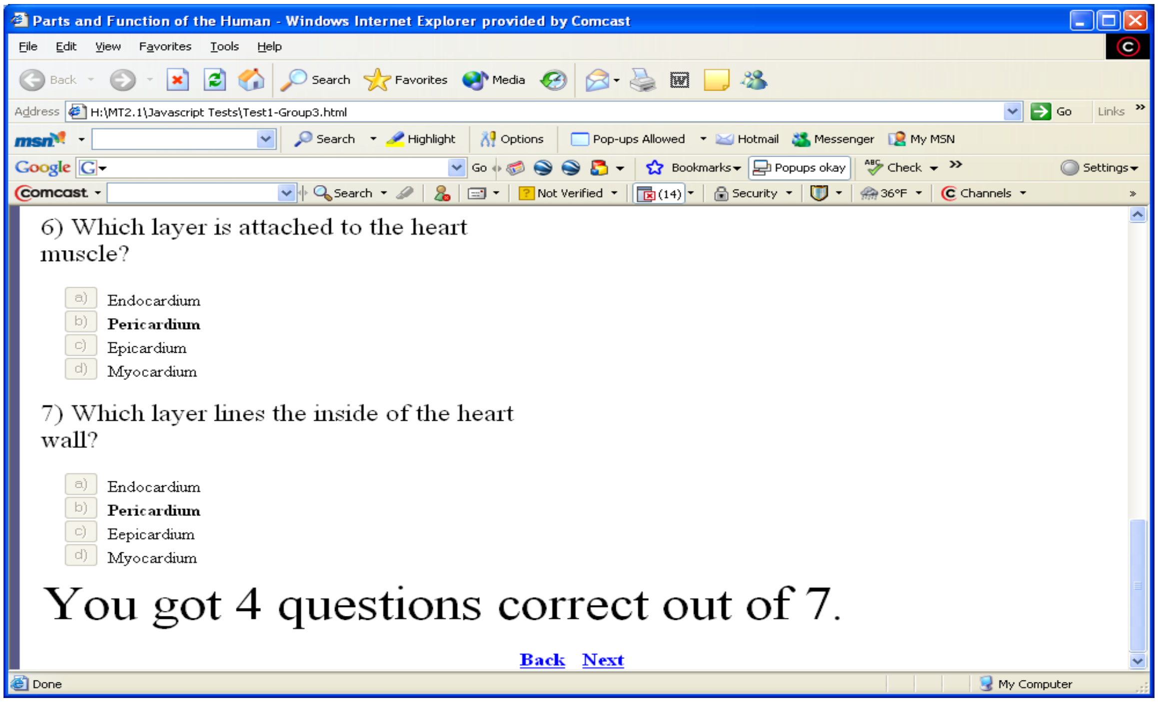


Figure 12: Example no feedback Frame



Online Game (Broken Heart Game)

A computer game was created and presented in an online environment where individuals would play for the purpose of learning. It was a variation of a jigsaw puzzle. Learners answered 20 multiple choice questions about the human heart and its functions. The questions and the choices were presented at the bottom of the screen; a time and score function on the top of the screen. On the right of the screen there was a faded human heart frame. On the left side there were little images of heart pieces. The questions were worded differently from the practice and achievement tests to avoid repetitions. Each correct answer placed one piece of the human heart in the correct location on the heart frame. Each correct answer gave the player 10 points, each consecutive 4 correct answers brought 20 extra points to the player. Players completed the game with a maximum of 300 points. There was a bonus question worth 50 points for those who completed with full points. If they answered that question correctly they not only got the extra points but also animated the completed human heart. There was only one person who got the extra bonus points and made the heart beat out of 180 participants.

Before the game there was an instruction frame about how to play the game. During the game, the right answer was highlighted in green and blinked. A wrong one was only highlighted in orange and did not blink. If a question was answered wrongly, the piece still went to the right location on the heart frame after the participant clicked on an answer, although the student did not earn any points for that question. Each time the game was played the questions were reset to be presented in a different order. Only the player's first game score was recorded for this study. This was to prevent the same student from playing the game more than one time. Also it prevented different players from copying each other's responses. The time used for game ranged from 108 seconds to 475 seconds.

Figure 13. Instruction frame for the game

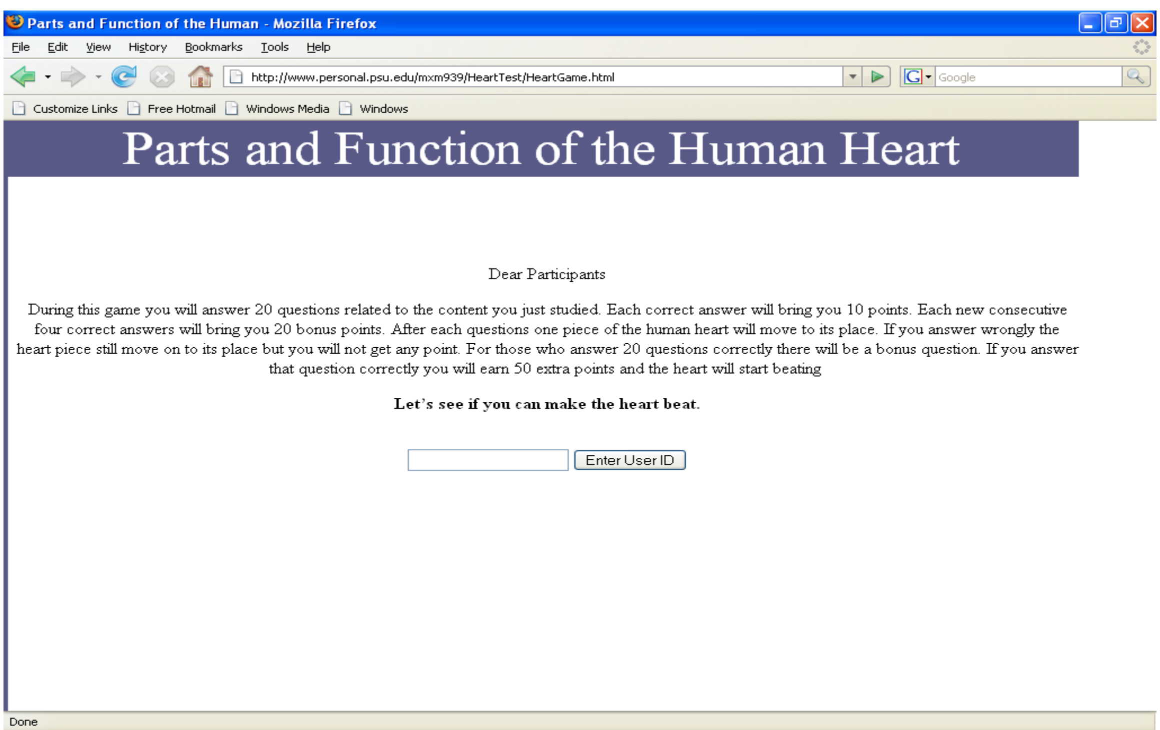
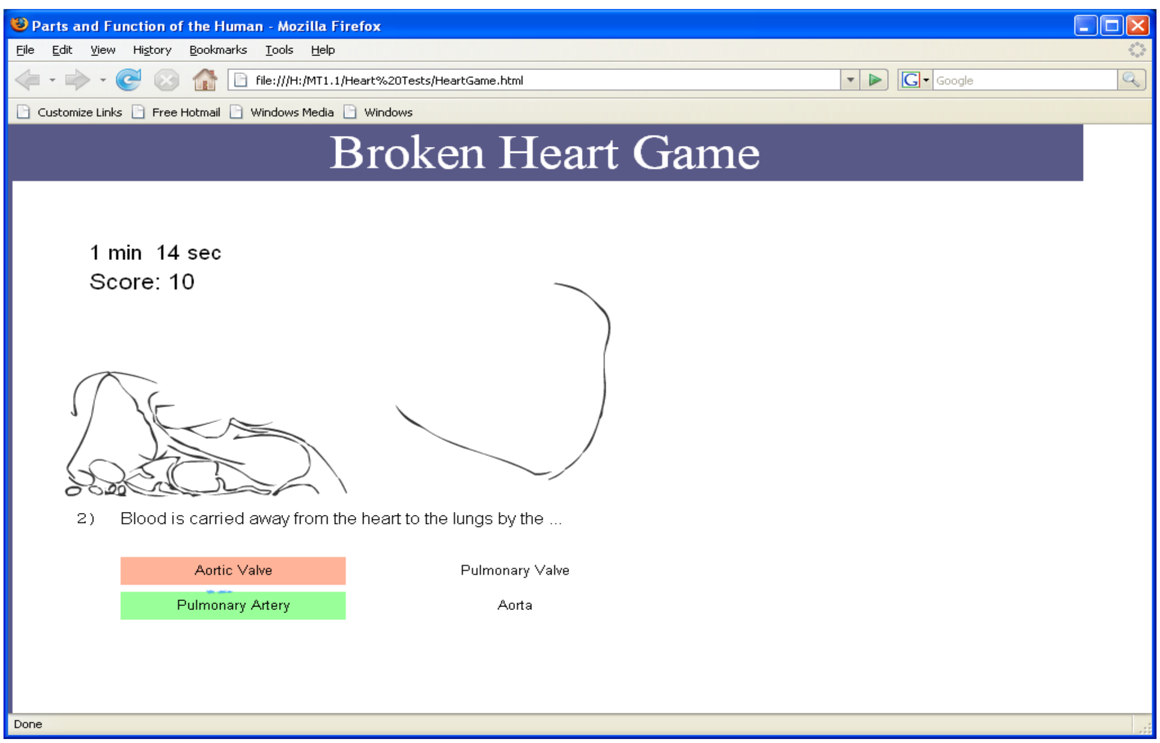


Figure 14. Example game frame correct answer

Figure 15. Example game frame with wrong answer



The entire game frames are presented in the Appendix D.

Enhanced Items

All enhancement strategies were intended to enhance questions on terminology and comprehension tests. Since these two tests targeted different types of learning objectives (concepts, rules/principals and comprehension) they also enhanced identification test questions, which are facts. The drawing test which was used in the pilot studies (1, 2, and 3) was not used in this study. Previously participants first went through the instruction online, took the paper-pencil form of the drawing test next, and then continued with the identification, terminology and comprehension tests. This was causing movement and noise in the lab, affecting participants' attention along with adding extra time to the studies. This researcher wanted the study to be completed exclusively online. Additionally the drawing test also measured the same concepts as on the terminology test.

The following table shows the questions that were enhanced by different treatments.

Table 2. List of questions enhance with different treatments

	Identification	Terminology	Comprehension	Total
Animation	2, 4, 5, 6, 7, 8, 9, 11, 13, 14, 16, 17, 18, 19 (14 items)	1, 2, 6, 8, 10, 11, 12, 13, 14, 19 (10 items)	2, 4, 6, 7, 9, 10, 15, 16, 18 (9 items)	33/60
Chunking Strategies	2, 3, 7, 11, 13, 14, 18 (7 items)	1, 5, 8, 9, 10, 11, 13, 14, 18 (9 items)	2, 4, 5, 6, 14, 15, 16, 17, 18, 20 (10 items)	27/60
Feedback	1-20 (20 items)	1, 2, 4, 5, 6, 7, 8, 9, 10, 11,12,13, 14, 15 16, 20 (16 items)	11, 12, 14, 16 (4 items)	40/60
Game	6,8,9,12 (4 items)	1, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 18, 19 (14 items)	1, 2, 3, 4, 6, 13 (6 items)	24/60

Item 1, 8, 10, 11, 13, 14 in terminology test, 12, 14, and 16 in comprehension test were enhanced with all strategies.

Description of Criterion Measures

Average Kuder-Richardson Formula 20 Reliability coefficients from a random sampling of studies (Dwyer, 1978) are .83 for the Terminology Test, .81 for the Identification Test, .83 for the Comprehension Test, and .92 for the Total Test. Following are descriptions of the criterion measures employed (Ibid. 45-47).

Identification Test: The objective of the identification test was to evaluate student ability to identify parts or positions of an object. This multiple-choice test of 20 items required students to identify the numbered parts on a detailed drawing of a heart. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test: This test consisted of 20 items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test were appropriate to all content areas which have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

Comprehension Test: Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specified parts or positions of other specified parts of the heart at the same time. This 20-item test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases.

Total Test Score: The (60) items contained in the individual criterion tests were combined into a composite test score. The purpose was to measure total achievement of the objectives presented in the instructional unit.

Table 3. Description of tests and respective criterion measure

Test	Description	Criterion measures
Identification	Identify part of the heart from given choices in a visual.	Facts
Terminology	Choose best response to measure knowledge of facts, terms, and definitions.	Concepts
Comprehension	Evaluate functions and positions of certain parts at a particular time when the heart is functioning.	Rules/principals/Comprehension
Total	Combine scores of above tests.	Facts, concepts, Rules/principles, comprehension

Cameron, B.H. (2004). The effect of gaming, cognitive style and feedback type in facilitating delayed achievement of different learning objectives (Doctoral Dissertation, Pennsylvania State University, 2004)

Description of Treatments

Treatment 1- Simple chunks + item-by-item feedback + game with animated program instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information and item-by-item feedback followed by an online game.

Treatment 2- Simple chunks + item-by-item feedback + no game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information and item-by-item feedback, with no game.

Treatment 3- Simple chunks + end-of-test feedback + game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information and end-of-test feedback followed by an online game.

Treatment 4- Simple chunks + end-of-test feedback + no game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information and end-of-test feedback, with no game.

Treatment 5- Simple chunks + no feedback + game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information and no feedback, followed by an online game.

Treatment 6- Simple chunks + no feedback + no game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information, with no feedback and no game.

Treatment 7- Complex chunks + item-by-item feedback + game with animated program instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with complex visual/text chunks of information and item-by-item feedback followed by an online game.

Treatment 8- Complex chunks + item-by-item + no game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with complex visual/text chunks of information and item-by-item feedback, with no game.

Treatment 9- Complex chunks + end-of-test feedback + game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with complex visual/text chunks of information and end-of-test feedback followed by an online game.

Treatment 10- Complex chunks + end-of-test feedback + no game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with complex visual/text chunks of information and end-of-test feedback, with no game.

Treatment 11- Complex chunks + no feedback + game with animated programmed instruction

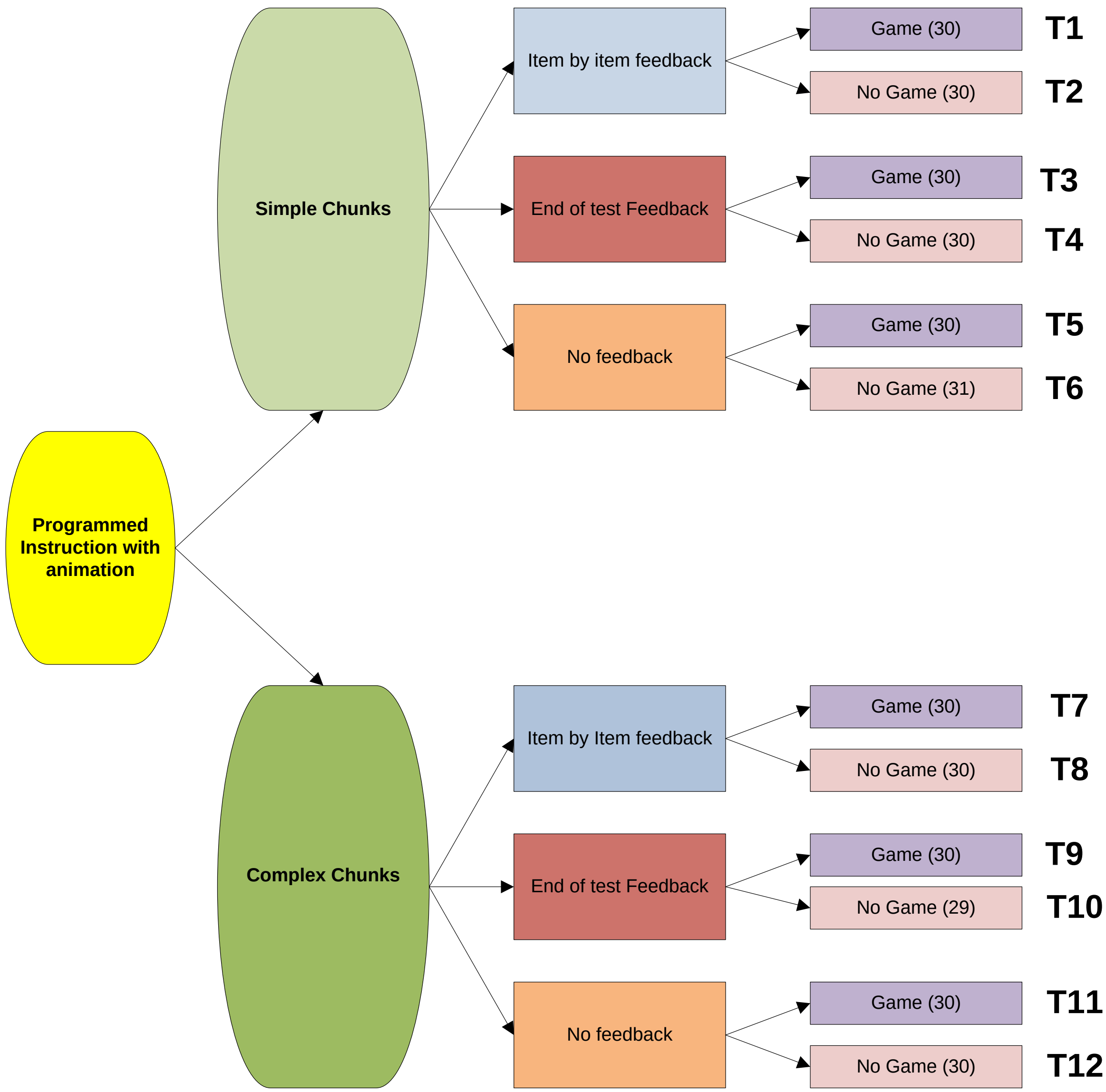
Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information, with no feedback but followed by an online game.

Treatment 12- Complex chunks + no feedback+ no game with animated programmed instruction

Individuals in this group received instruction in the content area with simple static and non-static (animated) instruction supported with simple visual/text chunks of information, with no feedback and no game.

All treatments provided attention-gaining opportunities to specific instruction along with rehearsal opportunities to retain the information in different ways. Game options (Treatments 1, 3, 5, 7, 9, 11) provided additional rehearsal opportunities along with learner motivation and interactivity. These were consequently expected to be more effective than no game options (Treatment 2, 4, 6, 8, 10, 12).

Figure 16. Research design and Treatment Groups (2X3X2)



A Total of 360 students randomly assigned into 12 treatments groups for this study.

Study Subjects

Students who participated in the study were undergraduates drawn from various departments in Pennsylvania State University. Students in the Biology or Pre-Med majors were excluded from the study to eliminate prior knowledge effect. When measuring achievement for this study it was preferred that the subjects not be familiar with the functioning of the heart, as that would detract from an ability to establish the impact of the specific instruction. Any students who were under the age of 18 were also excluded, as their inclusion would require the permission of a parent or legal guardian.

Procedure

Recruitment was performed in individual classrooms with the help and permission of the instructor. Students who agreed to be a part of the study went to a computer lab outside the class time and signed a consent form prior to the start of the study. An explanation describing the study was included on the informed consent form (See Appendix F).

The researcher also gave a short explanation on how to start and what to expect during the study. After that short explanation subjects were given a color-coded card which included an ID number for that student, a web address to a specific treatment, and a table to record beginning and ending times of the study. The cards were distributed in random order. The ID number on the card identified the treatment and the subject such as 01M12, 12M24... The First two digits, 01 through 12, denoted the treatment number; the last two digits were the subject number; and the letter in between was to separate the two.

Figure 17. An example assignment card

ID Number: 01M01 http://www.personal.psu.edu/mxm939/MT1.1/Introduction.html	
Beginning time:	Ending time:

The instructional treatments were self-paced, and the student indicated when ready for the test, after becoming satisfied with understanding of the instruction. The student then took the self-paced test that follows. The time that students spent on different treatments was recorded by the student onto the color-coded card and returned to the researcher. The study was completed in one session. Confidentiality of data was maintained at all times and access to data was limited to the researcher and the doctoral committee members.

Experimental Design

This study employed a Posttest-Only 2 x 3 x 2 factorial design. The independent variables of interest were the treatments. The dependent variables were the achievements on the post-tests.

Description of Statistical Approach

The purpose of this study was to empirically investigate the effect of various instructional strategies (chunking, feedback, and gaming) in complementing programmed animated instruction. There were two levels of Factor A (1: simple visual/text chunking, 2: complex visual/text chunking); three levels of Factor B (1: item-by-item feedback, 2: end-of-test feedback, 3: no feedback); and two levels of gaming (1: game, 2: no game). This study was conducted using a web based programmed instructional unit and evaluation. For each study participant the following data was recorded:

ID – a number assigned to the individual randomly in the order the person participated in the study such as 01M12, 02M01, etc.

Treatment Number indicated treatment 1 through 12 corresponding to the twelve treatments which are represented by the first two digit of ID number.

Achievement 1 - a score on the Identification component of the test.

Achievement 2 - a score on the Terminology component of the test.

Achievement 3 - a score on the Comprehension component of the test.

Total Test Score - a composite score was used as a measure of total achievement of the objectives presented in the instructional unit.

Game Score- a score on the online game ranging from 0 to 350.

With alpha level set at 0.05, MANOVA was employed to examine main and interaction affects on all criterion measures.

CHAPTER IV

RESULTS

This chapter provides an overview of statistical procedures performed in this study and a description of findings for each hypothesis.

Overview of Statistical Procedures

The results presented in this chapter are based on test scores of 360 students who participated in the study. Each participant received one of twelve treatments (1) simple chunks + item-by-item feedback + game with programmed instruction with animation (n = 30); (2) simple chunks + item-by-item feedback + no game with programmed instruction with animation (n = 30); (3) simple chunks + end-of-test feedback + game with programmed instruction with animation (n = 30); (4) simple chunks + end-of-test feedback + no game with programmed instruction with animation (n = 30); (5) simple chunks + no feedback + game with programmed instruction with animation (n = 30); (6) simple chunks + no feedback + no game with programmed instruction with animation (n = 31); (7) complex chunks + item-by-item feedback + game with programmed instruction with animation (n = 30); (8) complex chunks + item-by-item + no game with programmed instruction with animation (n = 30); (9) complex chunks + end-of-test feedback + game with programmed instruction with animation (n = 30); (10) complex chunks + end-of-test feedback + no game with programmed instruction with animation (n = 29); (11) complex chunks + no feedback + game with programmed instruction with animation (n = 30); and (12) complex chunks + no feedback + no game with programmed instruction with animation (n = 30). These are the conditions for the 2- chunking (simple visual/text vs. complex visual/text) by 3-feedback (item by item, end of test, and no feedback) by 2-game option (game vs. no game) fully crossed design. Although a total of 364 students participated, four participants' test results were eliminated from the data because two sets of scores were missing entirely (one on the terminology test, another on the comprehension test). The other two had only 1 correct answer on the terminology test.

The data was analyzed for different criterion measures (Identification, Terminology, Comprehension and Total) based on the number of correct responses for each of the twelve treatment groups. The data was analyzed using the Statistical Package for Social Sciences (SPSS), version 15.0. Multivariate analysis of variance (MANOVA) was used to examine the specified research hypotheses. A 2x3x2 factorial MANOVA tells whether there are overall significant main and interaction effects on all criterion measures. If so, then we can look at significant effects on specific dependent variables (i.e., univariate tests). Appropriate follow-up procedures would be followed for significant univariate effects (e.g., simple effects would be examined for significant interactions; Tukey's pairwise comparisons for significant main effects for factors with more than 2 levels. In this study the researcher used Wilks' Lambda test because it is the most common traditional test used in social science where there are more than two groups formed by independent variables. For instance the Roy's GCR is not as robust as others with respect to violations of assumptions of normality. Additionally the Hotelling's T and F are considered special cases of the Wilks' lambda (Tabachnick & Fidell, 2001).

Description of the results

MANOVA was utilized to determine whether the mean of post-test scores of the factors investigated, different instructional strategies (Factors A: simple and complex visual/text chunking, B: item-by-item feedback, end-of-test feedback and no feedback, C: game and no game) differed significantly from each other and whether the factors interacted significantly with each other. The analysis was conducted with respect to the criterion measures investigated (identification, terminology, comprehension).

Two different sets of analyses were conducted on the data. The first set of analyses (Tables 4 - 11) focused on all of the 60 multiple-choice questions that comprised the identification, terminology and comprehension tests and total (maximum score of 60). The second set of analyses (Tables 12 - 22) focused on only those items enhanced by different strategies. In the Identification test, there were seven questions enhanced by chunking strategies, and four questions by gaming. Feedback strategies enhanced all the questions. There were 10 questions enhanced by chunking strategies, 16 questions by feedback and 14 questions by gaming on the Terminology Test. This left the un-enhanced item count from 20 questions to 10, 16 and 14 respectively. There were 10 questions enhanced by chunking strategies, 4 questions by feedback and 6 questions by gaming on Comprehension Test, reducing the total test scores for these two tests from 20 questions to 10, 4, and 6 respectively.

Analysis Set 1- Sixty Post-Test Questions

In Analysis 1, descriptive statistics by treatment group are displayed in tables 4 - 7 for the three achievement tests (Identification, Terminology, Comprehension) and Total. The total mean for the Identification test was 15.32 with standard deviation 4. 418. For the Terminology test total mean was 13.16 with standard deviation 4.738. The Comprehension test had a total mean of 11.88 with standard deviation 4.566. The Grand mean was 40.36 with standard deviation 12.684. The reliability coefficients for the four criterion measures as derived from Cronbach's Alpha were as follows: .867 for Identification test, .853 for Terminology test, .825 for Comprehension test, and .940 for Total test. Study time ranged from 20 minutes to 85 minutes.

Table 4. Descriptive Statistics for the Identification Test

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	15.90	4.780	30	4-20
2			No Game	15.37	4.131	30	4-20
3		End of Test	Game	15.60	5.210	30	3-20
4			No Game	15.40	4.039	30	5-20
5		No Feedback	Game	15.63	4.189	30	5-20
6			No Game	15.58	4.493	31	4-20
7	Complex	Item-by-item	Game	14.87	4.208	30	3-20
8			No Game	13.40	5.177	30	5-20
9		End of Test	Game	16.60	3.829	30	8-20
10			No Game	14.83	4.184	29	6-20
11		No Feedback	Game	15.97	3.810	30	4-20
12			No Game	14.70	4.677	30	5-20
Total				15.32	4.418	360	3-20

Table 5. Descriptive Statistics for the Terminology Test

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	14.13	4.400	30	3-20
2			No Game	12.33	4.663	30	3-20
3		End of Test	Game	13.23	4.776	60	3-20
4			No Game	13.17	4.300	60	5-20
5		No Feedback	Game	13.97	4.745	30	4-20
6			No Game	13.29	5.337	31	2-20
7	Complex	Item-by-item	Game	12.43	5.042	30	4-20
8			No Game	11.53	5.450	30	3-20
9		End of Test	Game	14.53	4.470	30	5-20
10			No Game	12.00	4.234	29	4-18
11		No Feedback	Game	15.07	4.034	30	6-20
12			No Game	12.20	4.597	30	5-19
Total				13.16	4.738	360	2-20

Table 6. Descriptive Statistics for the Comprehension Test

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	13.23	4.133	30	4-20
2			No Game	11.23	4.224	30	4-20
3		End of Test	Game	12.07	4.975	30	3-20
4			No Game	11.93	3.903	30	5-20
5		No Feedback	Game	12.23	4.833	30	3-20
6			No Game	11.97	4.498	31	2-19
7	Complex	Item-by-item	Game	11.70	4.786	30	4-19
8			No Game	9.83	5.160	30	3-20
9		End of Test	Game	13.20	4.334	30	2-19
10			No Game	10.38	4.640	29	2-17
11		No Feedback	Game	13.03	3.819	30	4-18
12			No Game	11.63	4.774	30	4-20
Total				11.88	4.566	360	2-20

Table 7. Descriptive Statistics for the Total Test

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	43.27	12.180	30	13-58
2			No Game	38.93	11.620	30	13-60
3		End of Test	Game	40.90	13.440	30	13-59
4			No Game	40.50	11.206	30	16-60
5		No Feedback	Game	41.83	12.671	30	14-59
6			No Game	40.84	13.784	31	8-58
7	Complex	Item-by-item	Game	39.00	12.779	30	17-58
8			No Game	34.77	15.122	30	14-60
9		End of Test	Game	44.33	11.692	30	15-59
10			No Game	37.21	11.836	29	13-54
11		No Feedback	Game	44.07	10.761	30	19-57
12			No Game	38.53	13.161	30	16-57
Total				40.36	12.684	360	8-60

Table 8. Between-Subjects Factors

		Value Label	N
Chunking	1	Simple	181
	2	Complex	179
Feedback	1	Item by Item	120
	2	End of Test	119
	3	No Feedback	121
Game Option	1	Game	180
	2	No Game	180

Table 9. Wilks' Lambda Multivariate Tests

Effect	Value	F	Hypothesis df	Error df	P
Chunking	.996	.472	3	346	.702
Feedback	.986	.827	6	692	.549
GameOption	.967	3.883	3	346	.009
Chunking*Feedback	.989	.634	6	692	.703
Chunking*GameOption	.994	.659	3	346	.578
Feedback*GameOption	.988	.727	6	692	.628
Chunking*Feedback*GameOption	.982	1.050	6	692	.391

Table 10. Tests of Between Subjects Effects for Chunking, Feedback and Gaming

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	P
Chunking	Ident	24.327	1	24.327	1.246	.265
	Termin	13.886	1	13.886	0.631	.428
	Compr	20.854	1	20.854	1.019	.314
	Total	174.907	1	174.907	1.105	.294
Feedback	Ident	35.402	2	17.701	0.907	.405
	Termin	63.987	2	31.993	1.453	.235
	Compr	31.062	2	15.531	0.759	.469
	Total	352.408	2	176.204	1.113	.330
Gameopt	Ident	69.994	1	69.994	3.585	.059
	Termin	195.461	1	195.461	8.878	.003
	Compr	180.009	1	180.009	8.792	.003
	Total	1279.044	1	1279.044	8.080	.005
Chunking*Feedback	Ident	46.663	2	23.331	1.195	.304
	Termin	33.105	2	16.552	0.752	.472
	Compr	46.734	2	23.367	1.141	.321
	Total	358.556	2	179.278	1.132	.323
Chunking*Gameopt	Ident	34.584	1	34.584	1.772	.184
	Termin	35.281	1	35.281	1.602	.206
	Compr	34.005	1	34.005	1.661	.198
	Total	311.593	1	311.593	1.968	.162
Feedback*Gameopt	Ident	2.236	2	1.118	0.057	.944
	Termin	4.039	2	2.019	0.092	.912
	Compr	18.425	2	9.213	0.450	.638
	Total	15.651	2	7.825	0.049	.952
Chunking*Feedback*Gameopt	Ident	1.532	2	0.766	0.039	.962
	Termin	52.361	2	26.181	1.189	.306
	Compr	29.802	2	14.901	0.728	.484
	Total	181.721	2	90.861	0.574	.564

Note: Error degrees of freedom (df) were 348.

Analysis Set 1- Sixty Post-Test Questions

The Wilks' Lambda multivariate test of overall differences among groups were as follows:

Interactions

There was no statistically significant interaction effect for chunking and feedback strategies, $F(6, 692) = .634$, $p = .703 > .05$. There was no statistically significant interaction effect for chunking and gaming, $F(3, 346) = .659$, $p = .578 > .05$. There was no statistically significant interaction effect for feedback and gaming, $F(6, 692) = .727$, $p = .628 > .05$. There was no statistically significant interaction effect for chunking, feedback, and gaming, $F(6, 692) =1.050$, $p = .391 > .05$.

Chunking

There was no statistically significant main effect for chunking strategies in complementing animated programmed instruction, $F(3, 346) = .472$, $p = .702 > .05$.

Feedback

There was no statistically significant main effect for feedback in complementing animated programmed instruction, $F(6, 692) = .827$, $p = .549 > .05$.

Gaming

There was a statistically significant main effect for gaming in complementing animated programmed instruction, $F(3, 346) = 3.883$, $p = .009 < .05$. Univariate between-subjects tests showed that there was no statistically significant main effect related to gaming, F(1, 348) = 3.585, p = .059 > .05, on Identification test scores. There was a statistically significant main effect related to gaming, F(1, 348) = 8.878, p = .003 < .05, on the Terminology test scores and the Comprehension test scores, F(1, 348) = 8.792, p = .003 < .05. Participant who took the game option scored higher than the participants who took the no game option on Terminology and Comprehension tests (Means = 13.89 and 12.58 vs. 12.43 and 11.17 respectively).

Table 11. Group Statistics on Gaming on Terminology and Comprehension Tests

	Game Option	N	Mean	Std. Deviation
Terminology	Game	180	13.89	4.606
	No Game	180	12.43	4.767
Comprehension	Game	180	12.58	4.477
	No Game	180	11.17	4.557

Total Test Score

Univariate between-subjects tests showed that there was no significant main effect related to chunking F(1, 348) = 1.105, p = .294 > .05; feedback F(2, 348) = 1.113, p = .330 > .05 on Total test scores. There was a statistically significant main effect related to gaming F(1, 348) = 8.080, p = .005 < .05 on Total test scores.

Hypothesis 1

The findings obtain as a result of this investigation indicate that the first null hypothesis should be retained. There was no significant interaction among the treatment groups on the tests measuring different educational objectives.

Hypothesis 2

The findings obtain as a result of this investigation indicate that the second null hypothesis should be retained. There were no statistically significant differences in achievement between students in different levels of chunking treatment groups (simple visual/text and complex visual/text) on the tests measuring different educational objectives.

Hypothesis 3

The findings obtain as a result of this investigation indicate that the third null hypothesis should be retained. There were no statistically significant differences in achievement among students in different forms of feedback treatment groups (item-by-item, end-of-test and no feedback) on the tests measuring different educational objectives.

Hypothesis 4

The findings obtain as a result of this investigation indicate that the fourth null hypothesis should be rejected. There were statistically significant differences in achievement between students between the game and no game treatment groups on tests measuring different educational objectives (terminology and comprehension test scores). The participants who took the game option scored higher than the participants who took the no game option.

Analysis Set 2- Analysis of Items Enhanced by different Instructional Strategies (Chunking, Feedback and Gaming)

The second set of analyses was performed on specific items enhanced by different strategies. In the Identification test, there were seven questions enhanced by chunking strategies, and four questions by gaming. Feedback strategies enhanced all the questions in the Identification test. In Terminology there were 10 questions enhanced by chunking strategies, 14 questions by gaming and 16 questions by feedback. For the Comprehension test, 10 questions were enhanced by chunking strategies, 6 questions by feedback, and 4 questions by gaming.

In the analyses enhanced items were identified as follows:

EIC = Identification questions enhanced with chunking

EIG = Identification questions enhanced with gaming

ETC = Terminology questions enhanced with chunking

ETF = Terminology questions enhanced with feedback

ETG = Terminology questions enhanced with gaming

ECC = Comprehension questions enhanced with chunking

ECF = Comprehension questions enhanced with feedback

ECG = Comprehension questions enhanced with gaming

The descriptive statistics for items enhanced by different strategies are displayed in tables 12 – 19. The total mean for the items on the Identification test enhanced by chunking strategies was 5.43 with standard deviation 1.752. Items enhanced by gaming had a total mean of 3.09 with standard deviation 1.082. All Identification test items were enhanced by feedback. There was no need to perform another analysis on these items.

On the Terminology test total mean for items enhanced by chunking strategies was 5.21 with standard deviation 2.513. Items enhanced by feedback had a total mean of 10.37 with standard deviation 3. 903. Items enhanced by gaming had a total mean was 9.05 with standard deviation 3.440.

For the Comprehension test mean for items enhanced with chunking strategies was 5.25 with standard deviation 2.235. Items enhanced with feedback had a total mean of 2.38 with standard deviation 1.085. Those enhanced with gaming had a total mean was 3.80 with standard deviation 1.515. The Grand total mean for items enhanced by all strategies was 4.90 with standard deviations 2.309.

The reliability coefficients for the enhanced items as derived from Cronbach's Alpha were as follows: EIC = .729 (n = 7), EIG = .563 (n = 4), ETC = .752 (n = 9), ETF = .826 (n = 16), ETG = .806 (n = 14), ECC = .587 (n = 10), ECF = .392 (n = 4), NCG = .550 (n = 6), TE = .683 (n = 9).

In some of the analyses the reliability indices are low because of the small number of items.

Table 12. Descriptive Statistics for Identification Items Enhanced by Chunking (EIC)

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	5.40	1.905	30	0-7
2			No Game	5.50	1.635	30	1-7
3		End of Test	Game	5.63	1.938	30	0-7
4			No Game	5.57	1.478	30	2-7
5		No Feedback	Game	5.27	1.964	30	0-7
6			No Game	5.13	2.277	31	0-7
7	Complex	Item-by-item	Game	5.33	1.709	30	2-7
8			No Game	4.73	1.946	30	1-7
9		End of Test	Game	6.03	1.326	30	2-7
10			No Game	5.28	1.601	29	2-7
11		No Feedback	Game	5.80	1.400	30	2-7
12			No Game	5.47	1.548	30	2-7
Total				5.43	1.752	360	0-7

Table 13. Descriptive Statistics for Identification Items Enhanced by Gaming (EIG)

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	3.30	1.088	30	0-4
2			No Game	3.17	0.986	30	1-4
3		End of Test	Game	3.20	1.157	30	0-4
4			No Game	3.20	0.961	30	1-4
5		No Feedback	Game	3.23	0.858	30	2-4
6			No Game	3.16	1.036	31	0-4
7	Complex	Item-by-item	Game	2.97	1.159	30	1-4
8			No Game	2.73	1.311	30	0-4
9		End of Test	Game	3.20	1.215	30	0-4
10			No Game	3.00	0.845	29	2-4
11		No Feedback	Game	3.23	1.006	30	0-4
12			No Game	2.63	1.217	30	1-4
Total				3.09	1.082	360	0-4

Table 14. Descriptive Statistics for Terminology Items Enhanced by Chunking (ETC)

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	5.63	2.173	30	1-9
2			No Game	4.60	2.673	30	0-9
3		End of Test	Game	5.10	2.564	30	0-9
4			No Game	5.17	2.493	30	1-9
5		No Feedback	Game	5.83	2.588	30	1-9
6			No Game	5.42	2.680	31	0-9
7	Complex	Item-by-item	Game	4.77	2.501	30	0-9
8			No Game	4.63	2.748	30	0-9
9		End of Test	Game	5.77	2.431	30	0-9
10			No Game	4.41	2.147	29	1-8
11		No Feedback	Game	6.47	2.177	30	1-9
12			No Game	4.70	2.466	30	1-9
Total				5.21	2.513	360	0-9

Table 15. Descriptive Statistics for Terminology Items Enhanced by Feedback (ETF)

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	11.13	3.569	30	2-16
2			No Game	9.80	3.916	30	3-16
3		End of Test	Game	10.53	3.794	30	3-16
4			No Game	10.30	3.544	30	4-16
5		No Feedback	Game	11.10	3.818	30	3-16
6			No Game	10.55	4.210	31	2-16
7	Complex	Item-by-item	Game	9.70	4.137	30	2-16
8			No Game	9.00	4.410	30	1-16
9		End of Test	Game	11.27	3.814	30	3-16
10			No Game	9.28	3.463	29	4-16
11		No Feedback	Game	12.10	3.315	30	5-16
12			No Game	9.67	4.163	30	3-16
Total				10.37	3.903	360	1-16

Table 16. Descriptive Statistics for Terminology Items Enhanced by Gaming (ETG)

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	9.73	3.258	30	1-14
2			No Game	8.40	3.244	30	1-14
3		End of Test	Game	9.27	3.443	30	1-14
4			No Game	8.83	3.239	30	2-14
5		No Feedback	Game	9.80	3.614	30	3-14
6			No Game	9.23	3.730	31	1-14
7	Complex	Item-by-item	Game	8.63	3.662	30	3-14
8			No Game	7.97	3.899	30	2-14
9		End of Test	Game	9.97	3.232	30	3-14
10			No Game	8.03	3.122	29	2-14
11		No Feedback	Game	10.50	2.968	30	2-14
12			No Game	8.20	3.231	30	3-13
Total				9.05	3.440	360	1-14

Table 17. Descriptive Statistics for Comprehensive Items Enhanced by Chunking (ECC)

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	5.93	1.929	30	1-10
2			No Game	5.03	2.076	30	2-10
3		End of Test	Game	5.63	2.442	30	1-10
4			No Game	4.67	2.202	30	1-10
5		No Feedback	Game	5.43	2.388	30	0-10
6			No Game	5.48	2.127	31	1-10
7	Complex	Item-by-item	Game	5.17	2.052	30	2-10
8			No Game	4.50	2.345	30	1-10
9		End of Test	Game	5.80	2.265	30	2-10
10			No Game	4.34	2.303	29	0-8
11		No Feedback	Game	5.80	2.156	30	1-10
12			No Game	5.17	2.198	30	1-10
Total				5.25	2.235	360	0-10

Table 18. Descriptive Statistics for Comprehensive Items Enhanced by Feedback (ECF)

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	2.77	1.104	30	0-4
2			No Game	2.27	0.944	30	0-4
3		End of Test	Game	2.60	1.003	30	1-4
4			No Game	2.20	1.031	30	1-4
5		No Feedback	Game	2.50	1.280	30	0-4
6			No Game	2.42	1.177	31	0-4
7	Complex	Item-by-item	Game	2.37	0.964	30	1-4
8			No Game	2.00	1.174	30	0-4
9		End of Test	Game	2.50	1.225	30	0-4
10			No Game	1.86	0.990	29	0-4
11		No Feedback	Game	2.73	0.980	30	1-4
12			No Game	2.30	0.877	30	1-4
Total				2.38	1.085	360	0-4

Table 19. Descriptive Statistics for Comprehensive Items Enhanced by Gaming

Treatment	Chunking	Feedback	Gameopt	Mean	St Dev	N	Score Range
1	Simple	Item-by-item	Game	4.27	1.413	30	1-6
2			No Game	3.47	1.383	30	1-6
3		End of Test	Game	4.00	1.486	30	1-6
4			No Game	3.87	1.332	30	1-6
5		No Feedback	Game	3.97	1.921	30	0-6
6			No Game	3.84	1.573	31	0-6
7	Complex	Item-by-item	Game	3.73	1.461	30	1-6
8			No Game	3.10	1.605	30	0-6
9		End of Test	Game	4.27	1.530	30	0-6
10			No Game	3.24	1.405	29	0-6
11		No Feedback	Game	4.27	1.258	30	1-6
12			No Game	3.57	1.406	30	1-6
Total				3.80	1.515	360	0-6

Table 20. Wilks' Lambda Multivariate Tests

Effect	Value	F	Hypothesis df	Error df	P
Chunking	.972	1.239	8	341	.275
Feedback	.927	1.655	16	682	.051
GameOption	.947	2.367	8	341	.017
Chunking*Feedback	.967	.717	16	682	.779
Chunking*GameOption	.987	.565	8	341	.806
Feedback*GameOption	.962	.827	16	680	.655
Chunking*Feedback*GameOption	.961	.856	16	682	.621

Table 21. Tests of Between-Subjects Effects

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	p
Chunking	EIC	.054	1	.054	.018	.895
	EIG	5.584	1	5.584	4.791	.029
	ETC	2.527	1	2.527	.411	.522
	ETF	14.468	1	14.468	.970	.325
	ETG	9.583	1	9.583	.829	.363
	ECC	4.939	1	4.939	1.010	.316
	ECF	2.453	1	2.453	2.143	.144
	ECG	3.786	1	3.786	1.704	.193
Feedback	EIC	8.911	2	4.455	1.455	.235
	EIG	.775	2	.387	.332	.717
	ETC	30.928	2	15.464	2.516	.082
	ETF	53.969	2	26.984	1.809	.165
	ETG	33.807	2	16.903	1.463	.233
	ECC	9.205	2	4.603	.941	.391
	ECF	2.472	2	1.236	1.080	.341
	ECG	4.690	2	2.345	1.056	.349
Gameopt	EIC	8.055	1	8.055	2.630	.106
	EIG	3.835	1	3.835	3.291	.071
	ETC	53.664	1	53.664	8.730	.003
	ETF	131.107	1	131.107	8.791	.003
	ETG	131.009	1	131.009	11.337	.001
	ECC	52.232	1	52.232	10.682	.001
	ECF	14.621	1	14.621	12.773	.000
	ECG	29.234	1	29.234	13.162	.000

Note: The error degrees of freedom (df) were 348.

Table 21 (Continued). Tests of Between-Subjects Effects

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	P
Chunking*Feedback	EIC	10.974	2	5.487	1.791	.168
	EIG	1.208	2	.604	.518	.596
	ETC	2.791	2	1.396	.227	.797
	ETF	23.712	2	11.856	.795	.452
	ETG	8.905	2	4.453	.385	.681
	ECC	7.944	2	3.972	.812	.445
	ECF	2.427	2	1.214	1.060	.348
	ECG	3.271	2	1.635	.736	.480
Chunking*Gameopt	EIC	6.291	1	6.291	2.054	.153
	EIG	1.713	1	1.713	1.470	.226
	ETC	8.761	1	8.761	1.425	.233
	ETF	22.584	1	22.584	1.514	.219
	ETG	16.355	1	16.355	1.415	.235
	ECC	2.204	1	2.204	.451	.502
	ECF	.523	1	.523	.457	.500
	ECG	4.207	1	4.207	1.894	.170
Feedback*Gameopt	EIC	.574	2	.287	.094	.911
	EIG	.861	2	.430	.369	.692
	ETC	4.626	2	2.313	.376	.687
	ETF	3.819	2	1.910	.128	.880
	ETG	2.904	2	1.452	.126	.882
	ECC	12.705	2	6.353	1.299	.274
	ECF	1.072	2	.536	.468	.626
	ECG	1.384	2	.692	.312	.732
Chunking*Feedback*Gameopt	EIC	1.254	2	.627	.205	.815
	EIG	.755	2	.378	.324	.723
	ETC	26.140	2	13.070	2.126	.121
	ETF	30.153	2	15.076	1.011	.365
	ETG	26.182	2	13.091	1.133	.323
	ECC	3.508	2	1.754	.359	.699
	ECF	.970	2	.485	.424	.655
	ECG	4.409	2	2.205	.993	.372

Note: The error degrees of freedom (df) were 348.

Analysis Set 2 - Items Enhanced by different Strategies (Chunking, Feedback, and Gaming)

Enhanced items analyses with chunking as a factor

There was no statistically significant main effect on enhanced items when chunking was a factor, $F(8, 341) = 1.239$, $p = .275 > .05$.

Enhanced items analyses with feedback as a factor

There was no statistically significant main effect on enhanced items when feedback was a factor, $F(16, 682) = 1.655$, $p = .051 > .05$.

Enhanced items analyses with gaming as a factor

There was a statistically significant main effect on enhanced items when gaming was a factor, $F(8, 341) = 2.367$, $p = .017 < .05$. The participants who took the game option scored higher than the participants who took the no game option on ETC, ETF, ETG and ECC, ECF, ECG when gaming was a factor.

Table 22. Group Statistics on Items Enhanced by Different Strategies

		Gaming	N	Mean	Std. Deviation
Terminology	ETC	Game	180	5.59	2.440
		No Game	180	4.83	2.534
	ETF	Game	180	10.97	3.769
		No Game	180	9.77	3.952
	ETG	Game	180	9.65	3.375
		No Game	180	8.45	3.409
Comprehension	ECC	Game	180	5.63	2.197
		No Game	180	4.87	2.215
	ECF	Game	180	2.58	1.093
		No Game	180	2.18	1.043
	ECG	Game	180	4.08	1.517
		No Game	180	3.52	1.463

Analysis Set 2 - Enhanced Items

Hypothesis 1

The first null hypothesis was not applicable to the items enhanced by different strategies.

Hypothesis 2

The findings obtain as a result of this investigation on the items enhanced by different strategies when chunking was a factor indicated that the second null hypothesis should be retained. Even though items enhanced by gaming on the Identification test (EIG) when chunking was a factor showed statistical significance, that could be due to the inflation of Alpha.

Hypothesis 3

The findings obtain as a result of this investigation on the items enhanced by different strategies when feedback was a factor indicated that the third null hypothesis should be retained.

Hypothesis 4

The findings obtain as a result of this investigation indicate that the fourth null hypothesis should be rejected. There were statistically significant differences in achievement between students between the game and no game treatment groups on the terminology and comprehension test scores on items enhanced by different strategies when gaming was a factor (ETC, ETF, ETC, ECC, ECF, ECG). The participants who took the game option scored higher than the participants who took the no game option.

CHAPTER V

SUMMARY AND DISCUSSION

This chapter examines and discusses the finding of the study**.**

The purpose of this study was to empirically investigate the effects of different instructional strategies in complementing programmed instruction with animation. The study was conducted using a web-based self-paced programmed instructional unit and assessment of different educational objectives on learners' performance on four different criterion measures (identification, terminology, comprehension and total test scores). The instructional and evaluative materials were developed and utilized in this study in order to determine optimal use of chunking, feedback types and gaming, which could help learning a content and retain it.
One objective of this study was to empirically investigate the effect of using different types of chunking (simple visual/text chunking and complex visual/text chunking), using different types of feedback (item-by-item, end-of-test, and no feedback) and gaming (game, no game) on measuring different educational objectives in order to determine an optimal chunking and feedback types supported by instructional gaming that can help learning potential optimized and reduce information loss. The second objective of this study was to determine if these strategies interacted differently.

The author was interested in whether or not instructional gaming and use of different chunking along with feedback in complementing programmed instruction with animation made significant differences in improving learning measuring different types of learning objectives.

Summary of research Method

A total of 360 participants' test scores on achieving different educational objectives were investigated in this study. Post-test only 2X3X2 factorial design was utilized. The participants were randomly assigned to a self-paced, online instructional unit on the parts and functions of the human heart. Subjects in different 12 treatments received programmed instruction with animation supported by the following additional instructional strategies:

Treatment #1 simple chunks + item-by-item feedback + game;

Treatment #2 simple chunks + item-by-item feedback + no game;

Treatment #3 simple chunks + end-of-test feedback + game;

Treatment # 4 simple chunks + end-of-test feedback + no game;

Treatment #5 simple chunks + no feedback + game;

Treatment #6 simple chunks + no feedback + no game;

Treatment # 7 complex chunks + item-by-item feedback + game;

Treatment # 8 complex chunks + item-by-item + no game;

Treatment # 9 complex chunks + end-of-test feedback + game;

Treatment #10 complex chunks + end-of-test feedback + no game;

Treatment #11 complex chunks + no feedback + game;

Treatment # 12 complex chunks + no feedback + no game. A total of 364 students participated in the study, although four of the data were eliminated because of incompleteness. MANOVA was used to determine whether the mean test scores of all factors were significantly different.

Table 23. Treatment Comparisons on 20-item Tests

Identification		Terminology		Comprehension	
Treatment	Mean	Treatment	Mean	Treatment	Mean
8	13.40	8	11.53	8	9.83
12	14.70	10	12.00	10	10.38
10	14.83	12	12.20	2	11.23
7	14.87	2	12.33	12	11.63
2	15.37	7	12.43	7	11.70
4	15.40	4	13.17	4	11.93
6	15.58	3	13.23	6	11.97
3	15.60	6	13.29	3	12.07
5	15.63	5	13.97	5	12.23
1	15.90	1	14.13	11	13.03
11	15.97	9	14.53	9	13.20
9	16.60	11	15.07	1	13.23

Table 24. Treatment Comparisons on Enhanced Items

EIC		EIG		ETC		ETF		ETG	
Treat	Mean	Treat	Mean	Treat	Mean	Treat	Mean	Treat	Mean
8	4.73	12	2.63	10	4.41	8	9.00	8	7.97
6	5.13	8	2.73	2	4.60	10	9.28	10	8.03
5	5.27	7	2.97	8	4.63	12	9.67	12	8.20
10	5.28	10	3.00	12	4.70	7	9.70	2	8.40
7	5.33	6	3.16	7	4.77	2	9.80	7	8.63
1	5.40	2	3.17	3	5.10	4	10.30	4	8.83
12	5.47	4	3.20	4	5.17	3	10.53	6	9.23
2	5.50	3	3.20	6	5.42	6	10.55	3	9.27
4	5.57	9	3.20	1	5.63	5	11.10	1	9.73
3	5.63	5	3.23	9	5.77	1	11.13	5	9.80
11	5.80	11	3.23	5	5.83	9	11.27	9	9.97
9	6.03	1	3.30	11	6.47	11	12.10	11	10.50

Table 25 Continued. Treatment Comparison on Enhanced Items

ECC		ECF		ECG	
Treat	Mean	Treat	Mean	Treat	Mean
10	4.34	10	1.86	8	3.10
8	4.50	8	2.00	10	3.24
4	4.67	4	2.20	2	3.47
2	5.03	2	2.27	12	3.57
12	5.17	12	2.30	7	3.73
7	5.17	7	2.37	6	3.84
5	5.43	6	2.42	4	3.87
6	5.48	5	2.50	5	3.97
3	5.63	9	2.50	3	4.00
11	5.80	3	2.60	11	4.27
9	5.80	11	2.73	1	4.27
1	5.93	1	2.77	9	4.27

Summary and Interpretation of the Results.

The statistical hypotheses examined in this study served as a framework for the design and implementation of the study. The hypotheses are now the basis for build conclusions of the results of this investigation.

Hypothesis 1

The findings obtained as a result of this investigation indicated that the first null hypothesis should be retained. There were no statistically significant main effects with respect to interaction among the factors (chunking, feedback and gaming) on measuring different types of learning objectives.

Hypothesis 2

The findings obtained as a result of this investigation indicated that the second null hypothesis should be retained. There were no statistically significant main effects with respect to the use of chunking strategies (simple visual/text and complex visual/text) in complementing programmed instruction with animation among 12 treatment groups in achievement of the different criterion measures (identification, terminology, comprehension and total). This was in contrast with prior research indicating that chunking strategies helped people increase their capacity to learn, retain, recall, and apply information by grouping that information into digestible units. Through chunking information is transferred faster from short-term memory to long-term memory and recalled more readily (Newell and Simon, 1972, Hunt and Ellis, 1999, Cooper, 1998; Plate, 2000, Carter, Hardy and Hardy, 2001; Chen and Mcgrath, 2003, Munyofu et al, 2007).

These results also contradicted the results of pilot #3 where complex visual/text chunking strategies showed statistically significant differences on Terminology and Comprehension test scores. This might be due to the way the chunking strategies were presented. On pilot #3 chunking strategies were presented on the same frame with the instruction (Munyofu, et al, 2007). In this study, the chunking strategies were presented as a link to a heart symbol. Participants clicked on the symbol which opened the page containing the strategies. After looking and reading the chunks presented they clicked on the close button to continue. The researcher's intention to present information this way was to put it consistently in the same order. It was expected that users would go through the instruction presented on a frame, then play the animation, next go through the chunked information or vice versa. The pages were arranged in a way that the participant could not go through the next page without going through each sequence. It is suspected that they clicked to open and to close without reading carefully. That lack of careful attention might have contributed to reduced effectiveness of chunking strategies. The way chunking strategies presented in this study might also not be the preference of the learners. This might be related to cognitive load theory especially germane cognitive load which is associated with processes that learners invest in schema construction and automation (Van Merrienboer & Ayers, 2008).

Another reason might be due to the other strategies used in this study. The chunking strategies might function better in an instructional setting when other instructional strategies were limited. It is suspected that when multiple instructional strategies are used as in this study (feedback, gaming, and programmed instruction with animation) students might be overloaded with the information which hindered their learning. When developing strategies used in this study, the prime concern was to prevent cognitive load in working memory. The more a person has to learn in a shorter time the more difficult it is to process the information. Through simplification of the learning task and presenting it in visual/text format might minimize extraneous cognitive load, which is the manner in which the learning tasks are presented (Van Merrienboer & Ayers, 2005). Chunks used in this study were created both visually and verbally to help learners to encode the information with dual channels explained in the Dual Coding Theory (Paivio, 1971, 1986, Clark and Paivio, 1991). However, there was no clear indication of what reduced the effectiveness of chunking strategies used in this study.

Hypothesis 3

The findings obtained as a result of this investigation indicated that the third null hypothesis should be retained. There were no statistically significant main effects with respect to the use of feedback strategies (item-by-item, end-of-test, and no feedback) in complementing programmed instruction with animation among the 12 treatment groups in achievement of the different criterion measures (identification, terminology, comprehension and total) and enhanced items by different strategies. The results of this investigation indicated that the use of feedback does make a difference in learning but not the type of feedback. This finding collaborates earlier studies which indicated there was no best type of feedback in computer based instruction for learners and learning outcomes (Buzhardt and Semb, 2002; Kulik and Kulik, 1988; Dempsey 1993; Pashler, Cepeda, Wixted, & Rohrer, 2005). The Findings of this research was also in agreement with the finding of a review done by Bangert-Drowns, Kulik, Kulik and Morgan (1991) that feedback in programmed instruction and computer based instruction was less effective than in text comprehension and conventional testing situation, especially when the content was more complex and the learners were given fewer cues, organizers and other instructional support (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991). The results on different types of feedback were inconclusive, stating that there are no best types of feedback in computer based instruction for learners and learning outcomes (Mason and Bruning, 2001). The results of this study indicated that not all types of feedback were equally effective in all situations, particularly in an environment where there were other instructional strategies used simultaneously.

The technology allowed the researcher to create highly interactive feedbacks that could be given in different formats. However the different types of feedback did little to promote learning. As with chunking strategies, this too might be related to germane cognitive load. The participants came from so many different disciplines that the researcher had no way of knowing how these learners would perceive, process and interpret the different types of chunking and feedback.

Hypothesis 4

The findings obtained as a result of this investigation indicated that the fourth null hypothesis should be rejected. There were statistically significant main effects with respect to the use of gaming among treatments on terminology and comprehension tests, which measured higher order learning outcomes. These findings suggested that the treatments that utilized an instructional game (T1, T3, T5, T7, T9, T11) provided the rehearsal and information processing opportunities to achieve better score on a test measuring concepts, rules and principles and comprehension than the treatments which did not utilize an instructional game (T2, T4, T6, T8, T10, T12). There were also statistically significant effects on the Terminology and Comprehension test scores when focusing on enhanced items. This finding was consistent with prior research that used gaming as an instructional tool. Instruction that incorporated game features led to improve learning (Amory, Naicker, Vincent, & Adams, 1999; McEacrharn, 2005; Whelan 2005; Demsey, Lucassen, & Rasmussen, 1996; Huang and Cappel, 2005; Cameron and Dwyer, 2005). Not only students who got the game options did better than those who did not get the game option, but also students who scored better on the game did better than those who scored poorly. Use of the game might help students to learn and rehearse the content without causing cognitive load. The instructional game might have motivated and challenged learners to do better, thus resulting in better learning.

This research was also guided by the dual coding theory that doubles the chance for retrieval if the information was presented both verbally and visually since the learners have two ways of accessing the information (Clark & Pavio, 1991). The game used in this study was created to help learners to rehearse information. Although there was a redundancy in the information it still did not create cognitive over load which could hinder learning. The game factors might be a motivating factor that resulted in enjoyment instead of load.

Limitations of the Study

There were no difficulties with sampling procedures, data analysis, and overall execution of the study. This study utilized a post-test only design. Every effort was made in this study to ensure proper randomization of participants into treatment groups. The study involved 360 undergraduate students from different programs at The Pennsylvania State University. The factors used in this study are limited to two types of chunking (simple visual/text and complex visual/text); three types of feedback (item-by-item, end-of-test, no feedback); finally game and no game options.

Generalizability of the study

The findings of this study may be generalized to the individuals or settings other than the individuals who participated in this study in the following ways. The participants were individuals who were from University Park and Harrisburg campuses of the Pennsylvania State University. This population is similar to undergraduates at other universities in the United States, particularly those who have not been previously exposed to the heart content. The instructional strategies used in this study were also similar to online learning environments.

1. The finding of this study may be helpful in the creation of effective chunking strategies (visual or text), feedback (item by item, end of test and no feedback) and gaming for the use of online instruction to facilitate learning activities.

2. The findings of this study suggest caution when presenting chunking strategies. They could be more effective if they are presented directly and in the same frame with the related instructional content.
3. Using instructional gaming similar to the one used in this study along with programmed instruction with animation can optimize student achievement in any content of the type involved in this study.
4. The findings of this study suggested to instructors, educators and trainers to be cautious in the use of different type of feedback in their instruction. There are factors to be considered when giving feedback in an online environment, such as learners preference, efficiency of producing the type of feedback, time and the use of other instructional strategies.
5. Constructing engaging and challenging games as simple as in this study could provide appropriate learning support.
6. Playing games which are directly related to measurement tools in rehearsal activities could be applied to other educational settings.
7. The findings of this research may enhance the awareness of different types of chunking strategies used visually and textually, different types of feedback, and instructional gaming as important variables other than to complement programmed instruction with animation.
8. The findings of research might be directed towards extending prior knowledge in the areas of chunking, feedback and gaming in achievement of different types of learning outcomes.

9. The findings of this research may contribute knowledge to the development of instructional systems design and learning theories.

Recommendations for Further Research

Based on the findings of this study, the following recommendations are made concerning further research in the field. There is a need to:

1. examine the use of animation in this study. The use of animation provides potential visual interest for presenting computer-based materials which make its learning more appealing and enjoyable to learners (ChanLin, 2000). However previous studies on the effect of animation were inconclusive (Reiber, 1990; Dwyer and Dwyer, 2003). It is important to identify principles of designing animation that could have an effect on learning;
2. examine what types of chunking strategies work more effectively in different settings;
3. examine how and where to present different types of chunking strategies in an online setting;
4. explore other type of feedback that are possible for online learning environments, along with how to increase the effectiveness of the feedback strategies presented in this study;
5. examine the effectiveness of each strategies by itself without additional support from other (and sometimes confounding) strategies used in this study. Some such strategies include interactivity;
6. examine this study with other populations to increase generalizability;
7. extend this study to understand how these strategies would affect retention of information;

8. examine learning outcomes if instructional unit and gaming are practiced by multiple participants. Games should promote dialogue and exchange of knowledge and opinions (Sandford and Williamson, 2005).

In summary, this research points to the theoretical and practical benefits of gaming in complementing programmed instruction with animation to facilitate different types of learning objectives. The game was created with consideration of instructional objectives of this study, matching those of the criterion measures, to increase students' interest and motivation. That led to achievement of different types of learning goals (facts, concepts, rules and principles and comprehension). Gaming was presented with visual and text representations. Visuals helped to attract the attention of, and motivate learners. Text representations helped learners recode and recall the information.

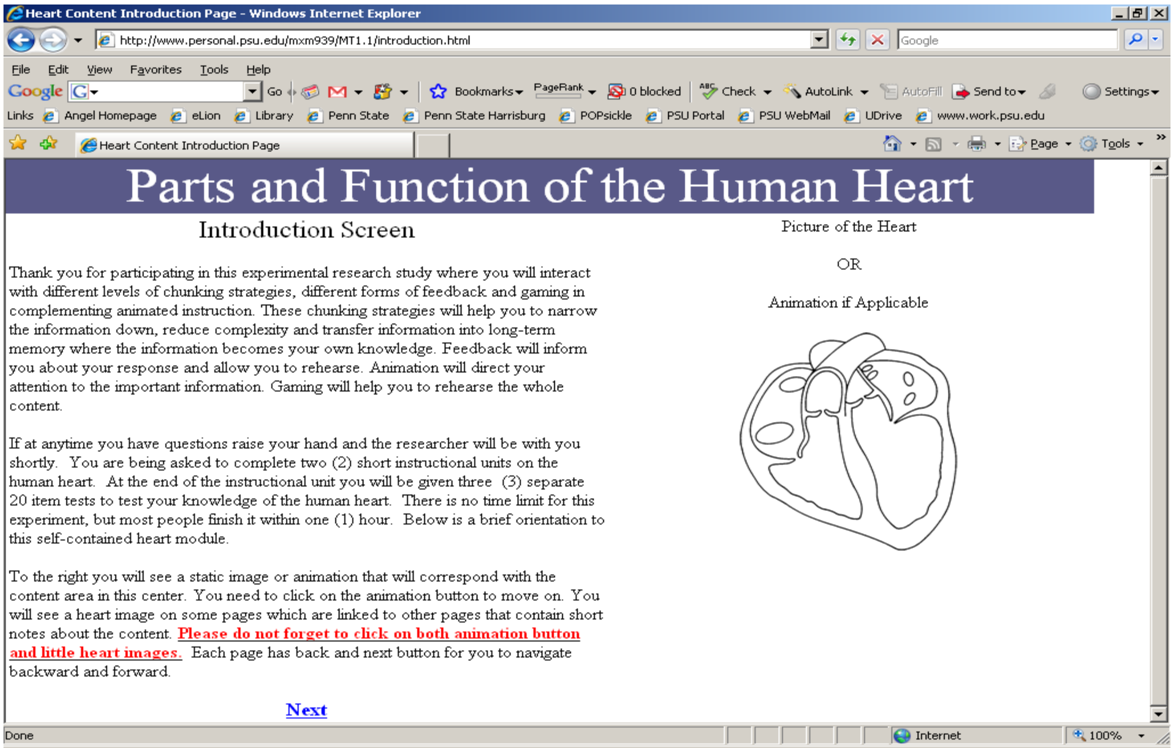
On the practical level, the study raised issues about the use of different types of chunking and feedback. The underlying reason for the use of chunking has been that of helping learners to reduce their cognitive load by helping them focus their attention to important information. In this study the results were not conclusive as with previous studies. Presenting chunking strategies in conjunction with additional strategies (feedback and gaming) could be one reason that might reduce the effectiveness of chunking strategies. Each additional strategy presented might increase the amount of the information to process in a given time and might cause cognitive overload. Secondly, participants were expected to go through the chunked information by clicking on a symbol. It was suspected that they opened and closed the chunked frames without carefully reading and understanding which caused the lack of significant differences.

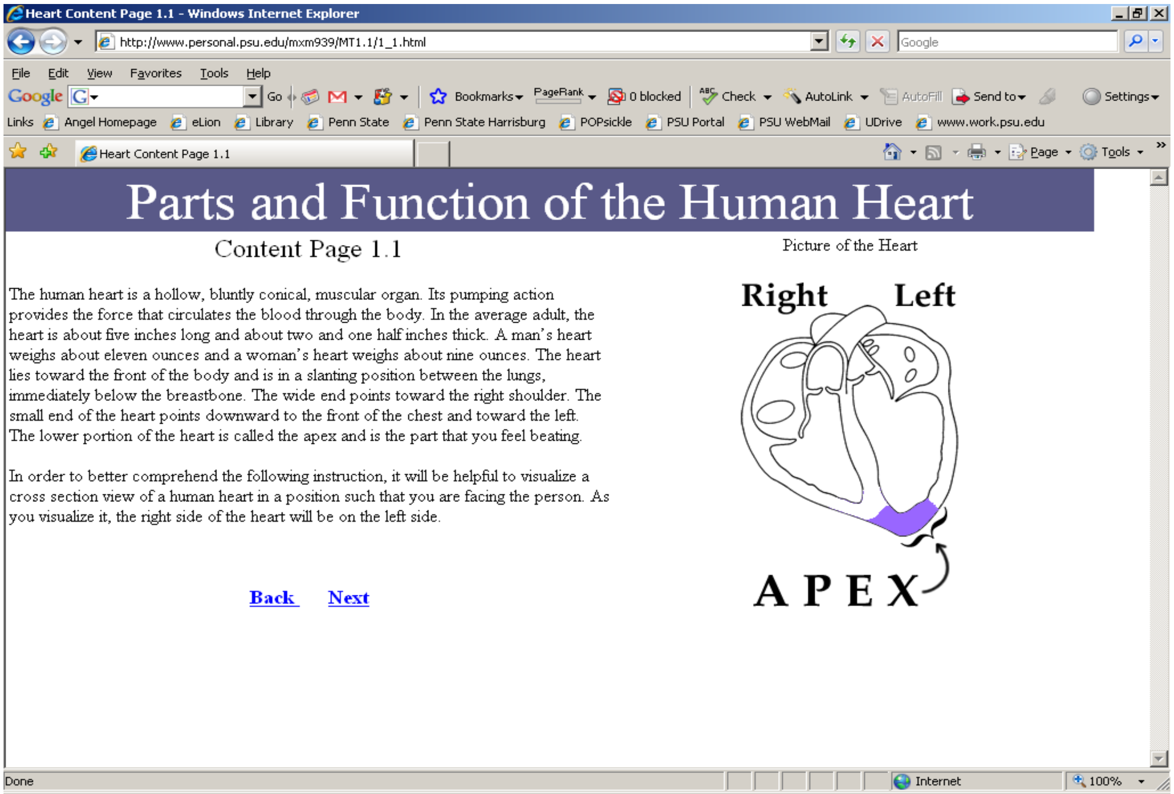
Instructors who are planning to include different type of chunking and feedback strategies in their online instruction need to take into considerations the efficiency of creating and presenting these strategies and the way they are presented. It is also important to know the users and provide a range of possible types of chunking and feedback to match their preferences.

APPENDICES

Appendix A

Complete Instructional Unit





Heart Content Page 1.1 - Windows Internet Explorer

http://www.personal.psu.edu/mxm939/MT1.1/1_1.html

Parts and Function of the Human Heart

Content Page 1.1

Picture of the Heart

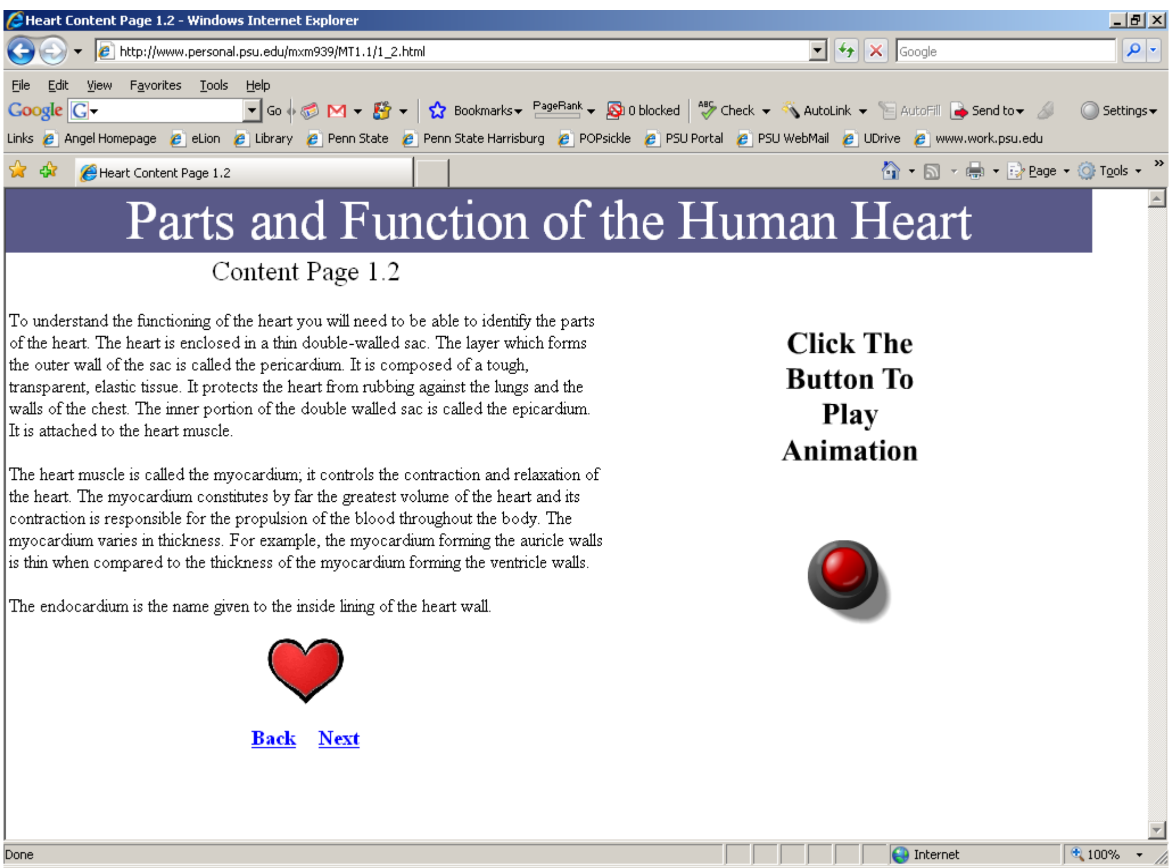
Right Left

APEX

The human heart is a hollow, bluntly conical, muscular organ. Its pumping action provides the force that circulates the blood through the body. In the average adult, the heart is about five inches long and about two and one half inches thick. A man's heart weighs about eleven ounces and a woman's heart weighs about nine ounces. The heart lies toward the front of the body and is in a slanting position between the lungs, immediately below the breastbone. The wide end points toward the right shoulder. The small end of the heart points downward to the front of the chest and toward the left. The lower portion of the heart is called the apex and is the part that you feel beating.

In order to better comprehend the following instruction, it will be helpful to visualize a cross section view of a human heart in a position such that you are facing the person. As you visualize it, the right side of the heart will be on the left side.

Back Next



Heart Content Page 1.2 - Windows Internet Explorer

http://www.personal.psu.edu/mxm939/MT1.1/1_2.html

Parts and Function of the Human Heart

Content Page 1.2

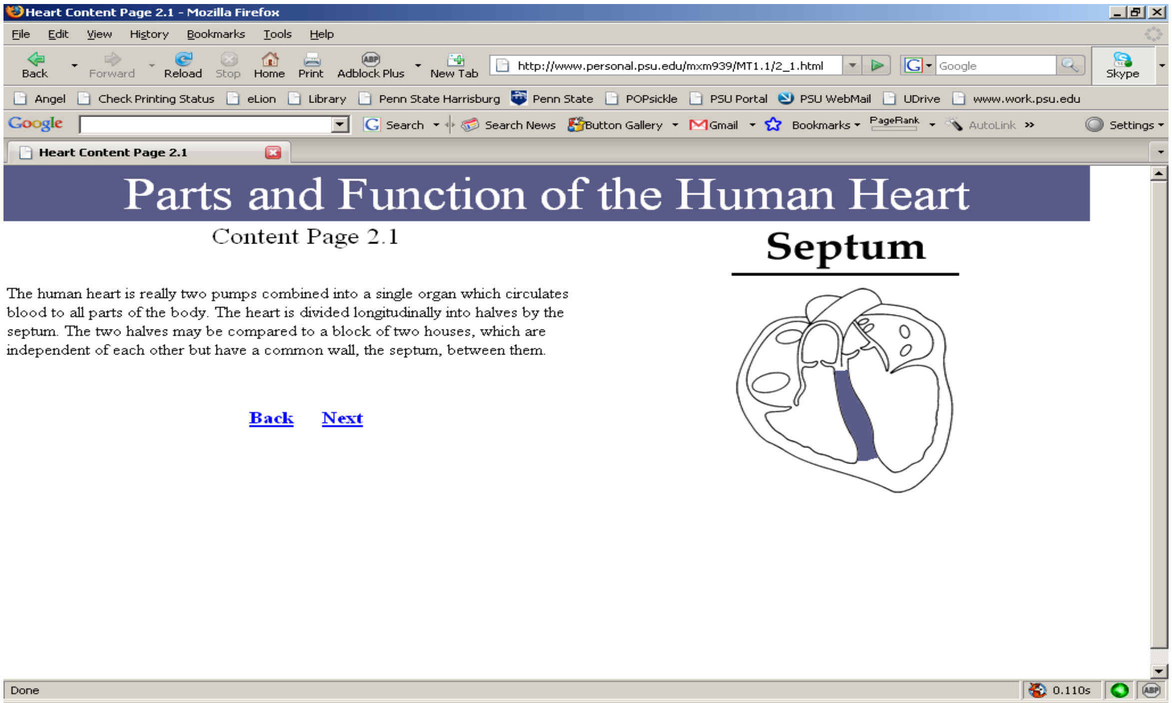
To understand the functioning of the heart you will need to be able to identify the parts of the heart. The heart is enclosed in a thin double-walled sac. The layer which forms the outer wall of the sac is called the pericardium. It is composed of a tough, transparent, elastic tissue. It protects the heart from rubbing against the lungs and the walls of the chest. The inner portion of the double walled sac is called the epicardium. It is attached to the heart muscle.

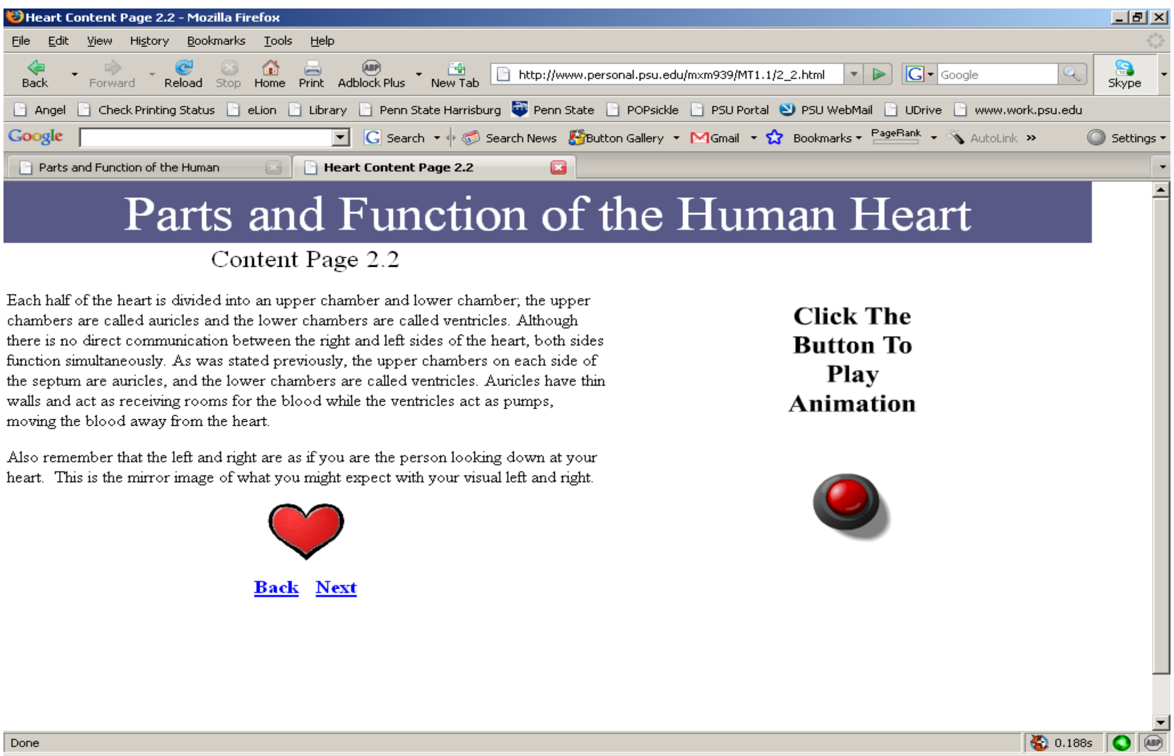
The heart muscle is called the myocardium; it controls the contraction and relaxation of the heart. The myocardium constitutes by far the greatest volume of the heart and its contraction is responsible for the propulsion of the blood throughout the body. The myocardium varies in thickness. For example, the myocardium forming the auricle walls is thin when compared to the thickness of the myocardium forming the ventricle walls.

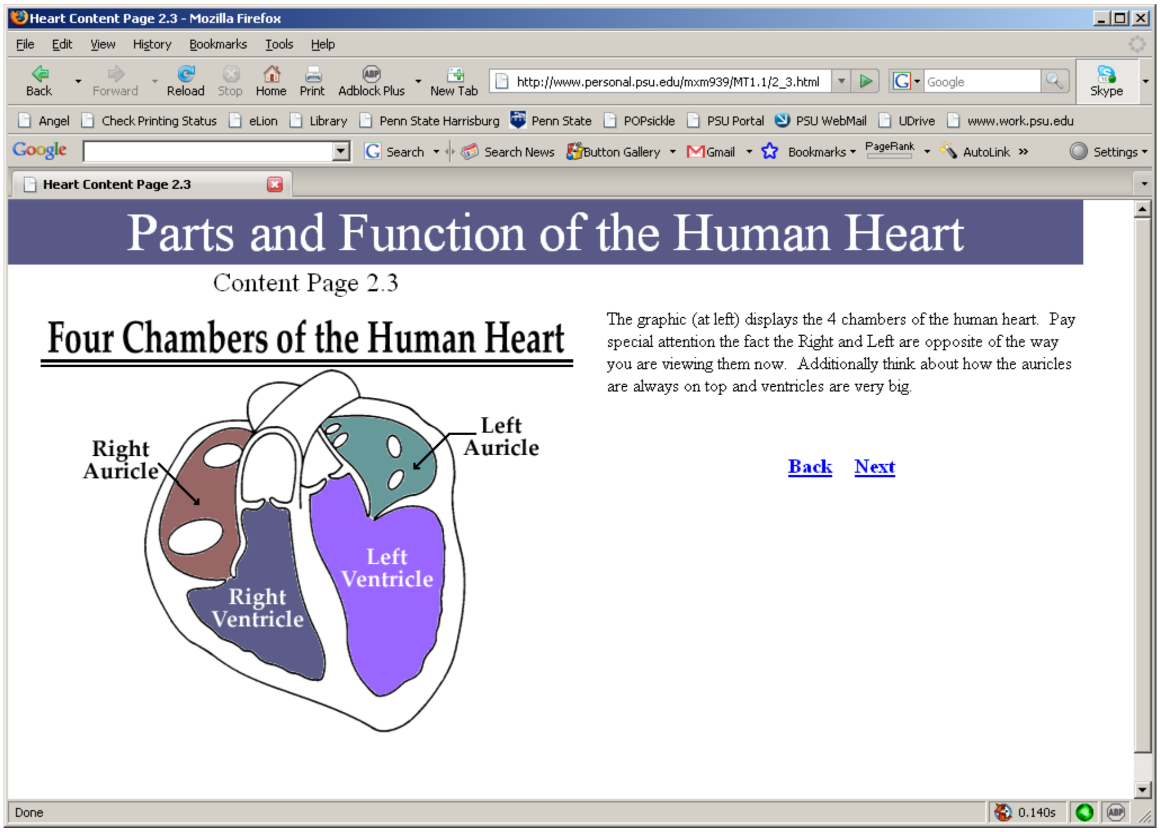
The endocardium is the name given to the inside lining of the heart wall.

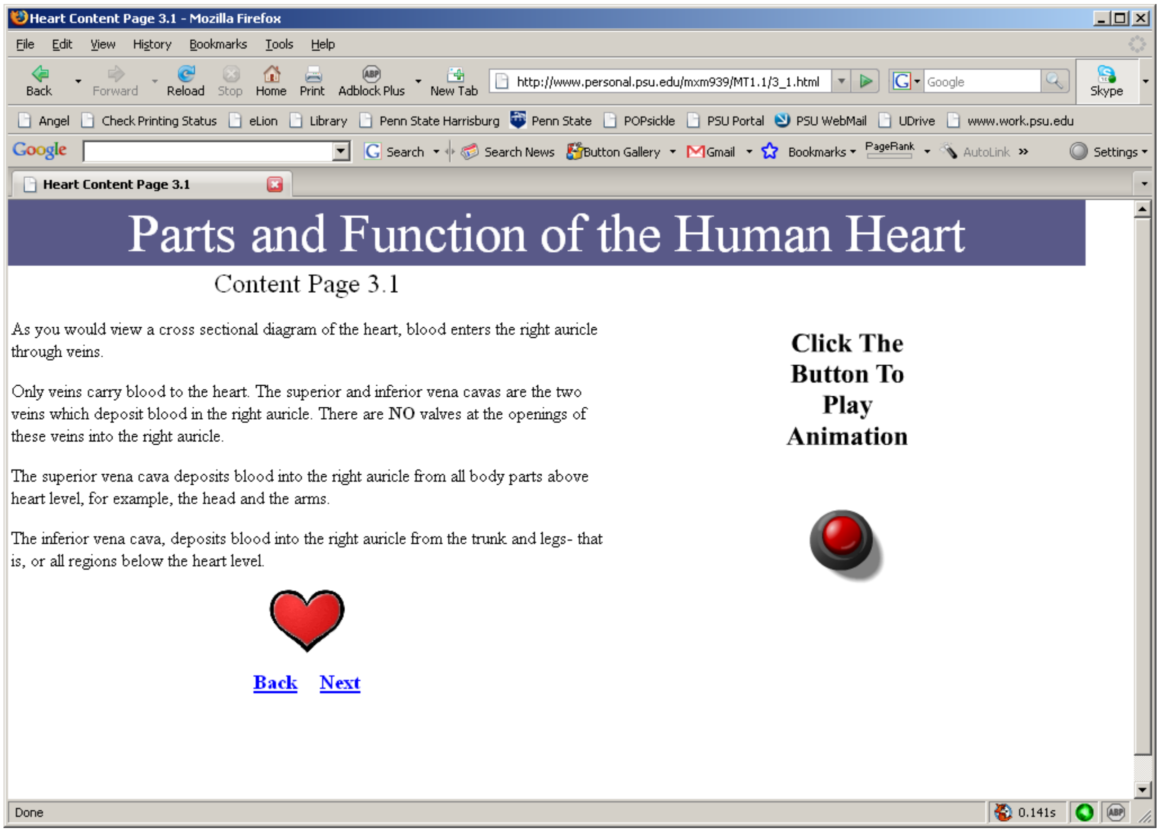
Click The Button To Play Animation

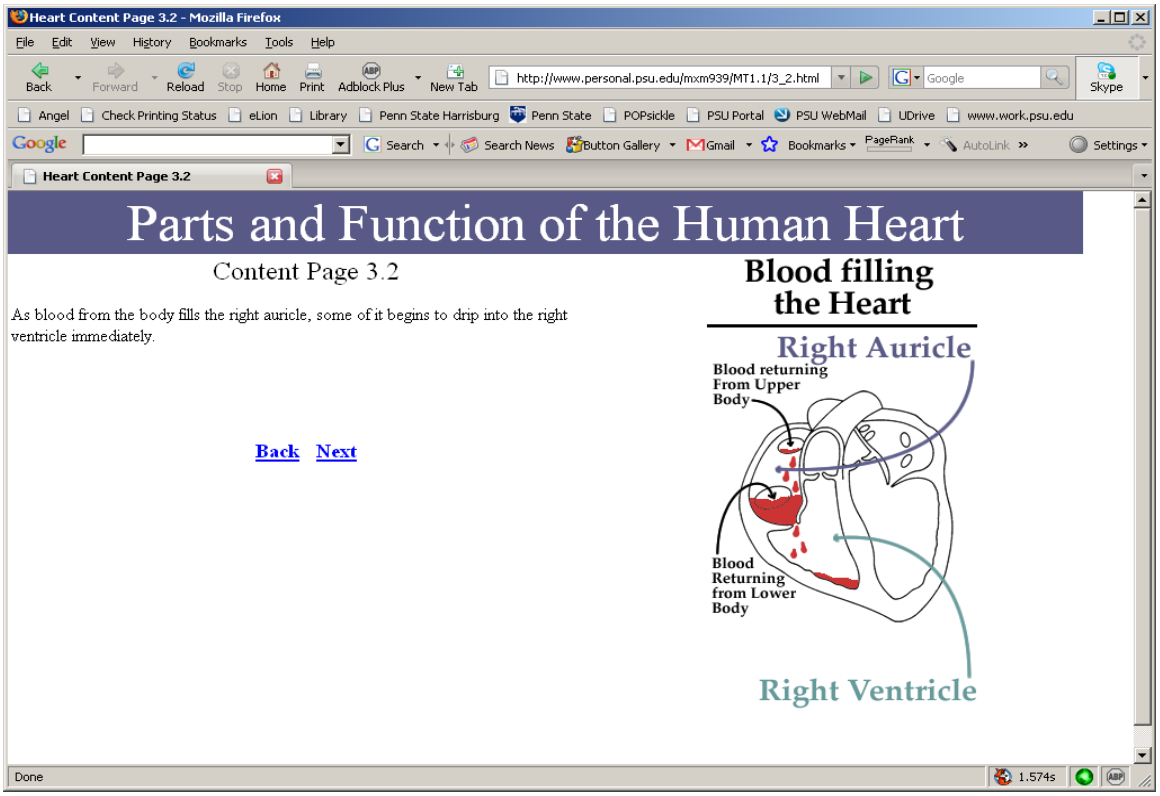
Back Next

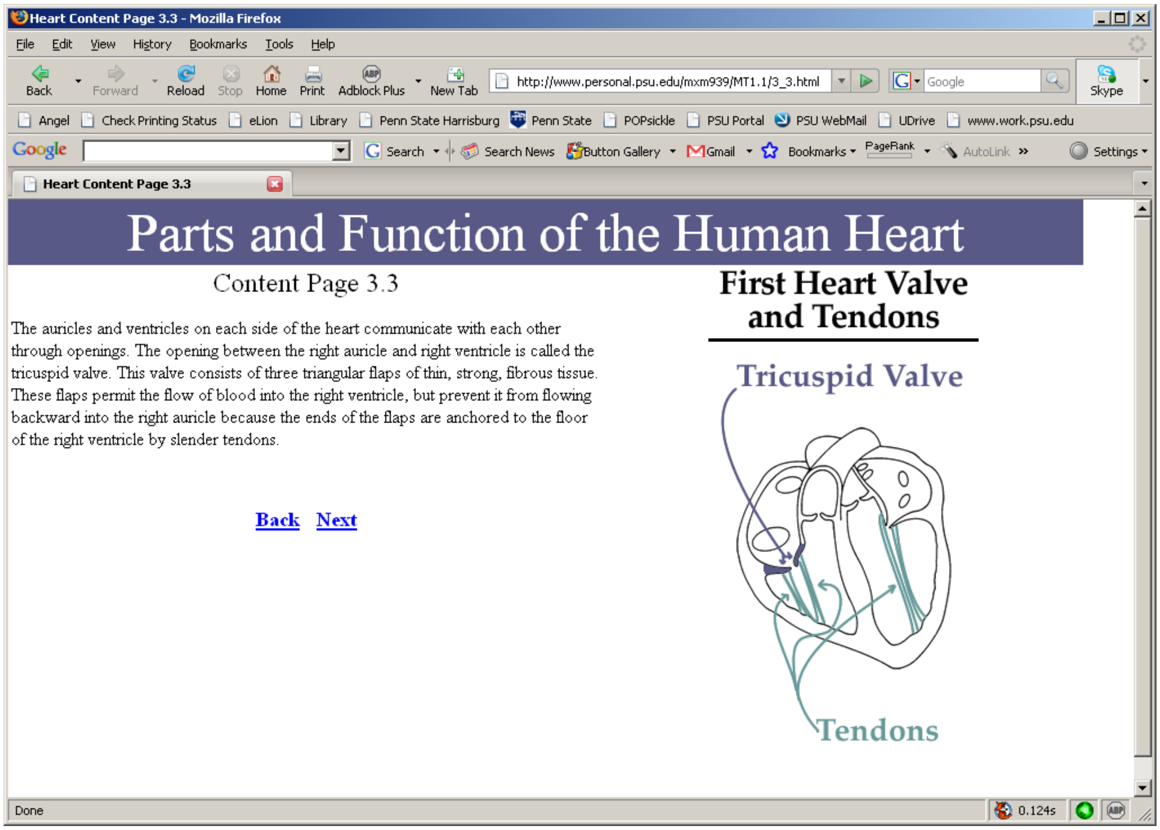

Heart Content Page 2.1 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/2_1.html
Heart Content Page 2.1
Parts and Function of the Human Heart
Content Page 2.1
Septum
The human heart is really two pumps combined into a single organ which circulates blood to all parts of the body. The heart is divided longitudinally into halves by the septum. The two halves may be compared to a block of two houses, which are independent of each other but have a common wall, the septum, between them.
Back Next
Done

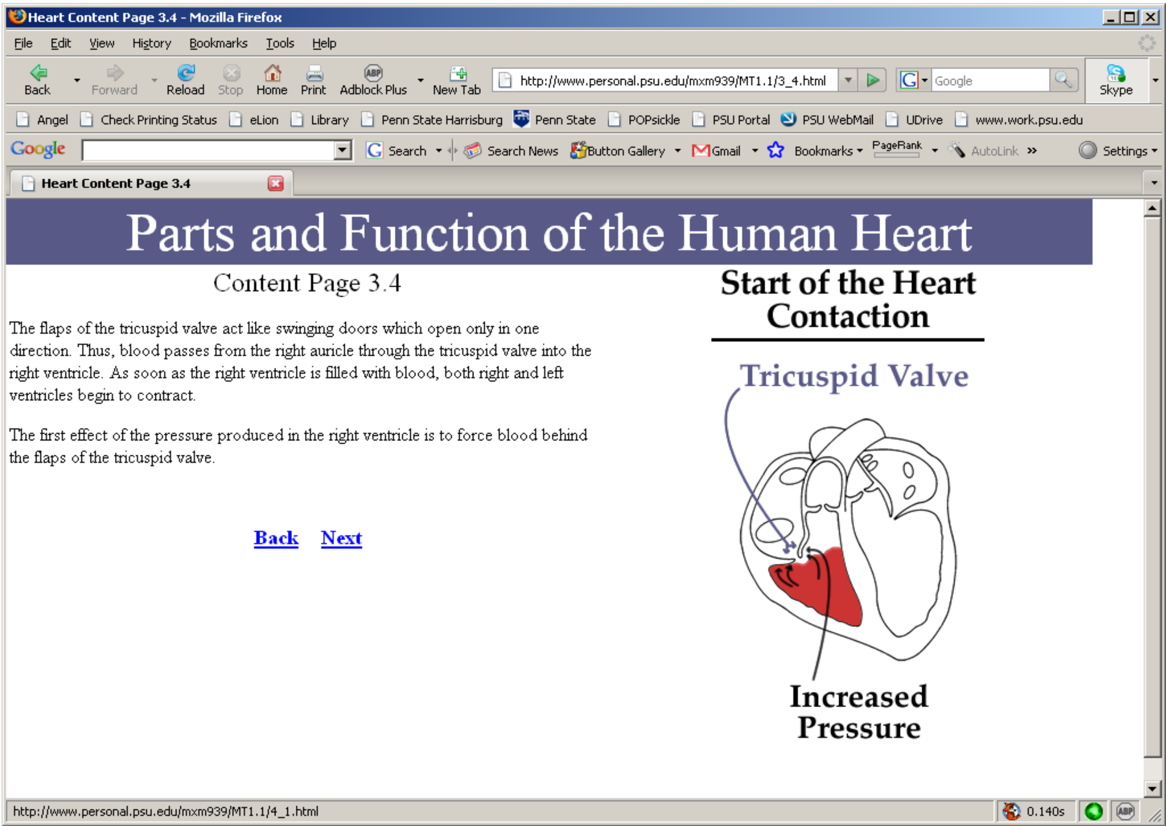

Heart Content Page 2.2 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/2_2.html
Parts and Function of the Human
Heart Content Page 2.2
Parts and Function of the Human Heart
Content Page 2.2
Each half of the heart is divided into an upper chamber and lower chamber; the upper chambers are called auricles and the lower chambers are called ventricles. Although there is no direct communication between the right and left sides of the heart, both sides function simultaneously. As was stated previously, the upper chambers on each side of the septum are auricles, and the lower chambers are called ventricles. Auricles have thin walls and act as receiving rooms for the blood while the ventricles act as pumps, moving the blood away from the heart.
Also remember that the left and right are as if you are the person looking down at your heart. This is the mirror image of what you might expect with your visual left and right.
Click The Button To Play Animation
Back Next
Done

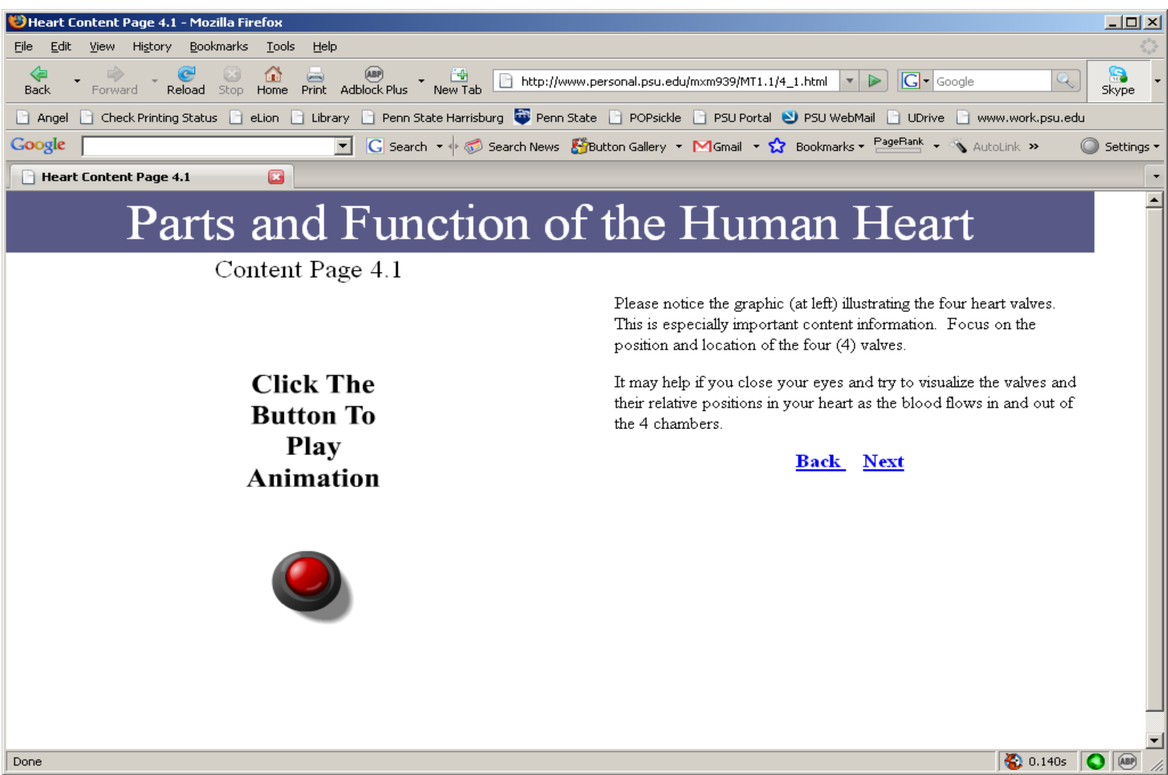

Heart Content Page 2.3 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/2_3.html
Parts and Function of the Human Heart
Content Page 2.3
Four Chambers of the Human Heart
Right Auricle
Left Auricle
Left Ventricle
Right Ventricle
The graphic (at left) displays the 4 chambers of the human heart. Pay special attention the fact the Right and Left are opposite of the way you are viewing them now. Additionally think about how the auricles are always on top and ventricles are very big.
Back Next
Done

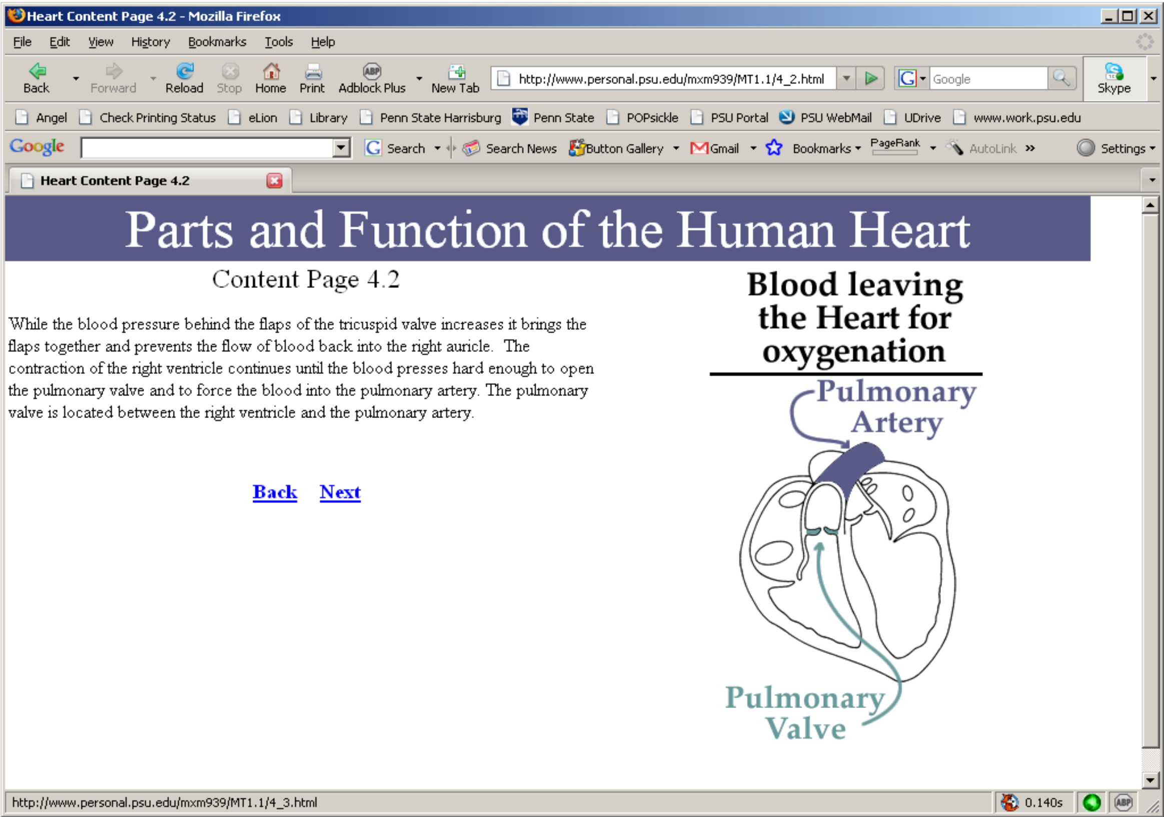

Heart Content Page 3.1 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/3_1.html
Parts and Function of the Human Heart
Content Page 3.1
As you would view a cross sectional diagram of the heart, blood enters the right auricle through veins.
Only veins carry blood to the heart. The superior and inferior vena cavas are the two veins which deposit blood in the right auricle. There are NO valves at the openings of these veins into the right auricle.
The superior vena cava deposits blood into the right auricle from all body parts above heart level, for example, the head and the arms.
The inferior vena cava, deposits blood into the right auricle from the trunk and legs- that is, or all regions below the heart level.
Click The Button To Play Animation
Back Next
Done


Heart Content Page 3.2 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/3_2.html
Parts and Function of the Human Heart
Content Page 3.2
As blood from the body fills the right auricle, some of it begins to drip into the right ventricle immediately.
Back Next
Blood filling the Heart
Right Auricle
Blood returning From Upper Body
Blood Returning from Lower Body
Right Ventricle


Heart Content Page 3.3 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/3_3.html
Parts and Function of the Human Heart
Content Page 3.3
The auricles and ventricles on each side of the heart communicate with each other through openings. The opening between the right auricle and right ventricle is called the tricuspid valve. This valve consists of three triangular flaps of thin, strong, fibrous tissue. These flaps permit the flow of blood into the right ventricle, but prevent it from flowing backward into the right auricle because the ends of the flaps are anchored to the floor of the right ventricle by slender tendons.
Back Next
First Heart Valve and Tendons
Tricuspid Valve
Tendons


Heart Content Page 3.4 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/3_4.html
Parts and Function of the Human Heart
Content Page 3.4
The flaps of the tricuspid valve act like swinging doors which open only in one direction. Thus, blood passes from the right auricle through the tricuspid valve into the right ventricle. As soon as the right ventricle is filled with blood, both right and left ventricles begin to contract.
The first effect of the pressure produced in the right ventricle is to force blood behind the flaps of the tricuspid valve.
Back Next
Start of the Heart Contaction
Tricuspid Valve
Increased Pressure
http://www.personal.psu.edu/mxm939/MT1.1/4_1.html


Heart Content Page 4.1 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/4_1.html
Parts and Function of the Human Heart
Content Page 4.1
Click The Button To Play Animation
Please notice the graphic (at left) illustrating the four heart valves. This is especially important content information. Focus on the position and location of the four (4) valves.
It may help if you close your eyes and try to visualize the valves and their relative positions in your heart as the blood flows in and out of the 4 chambers.
Back Next
Done



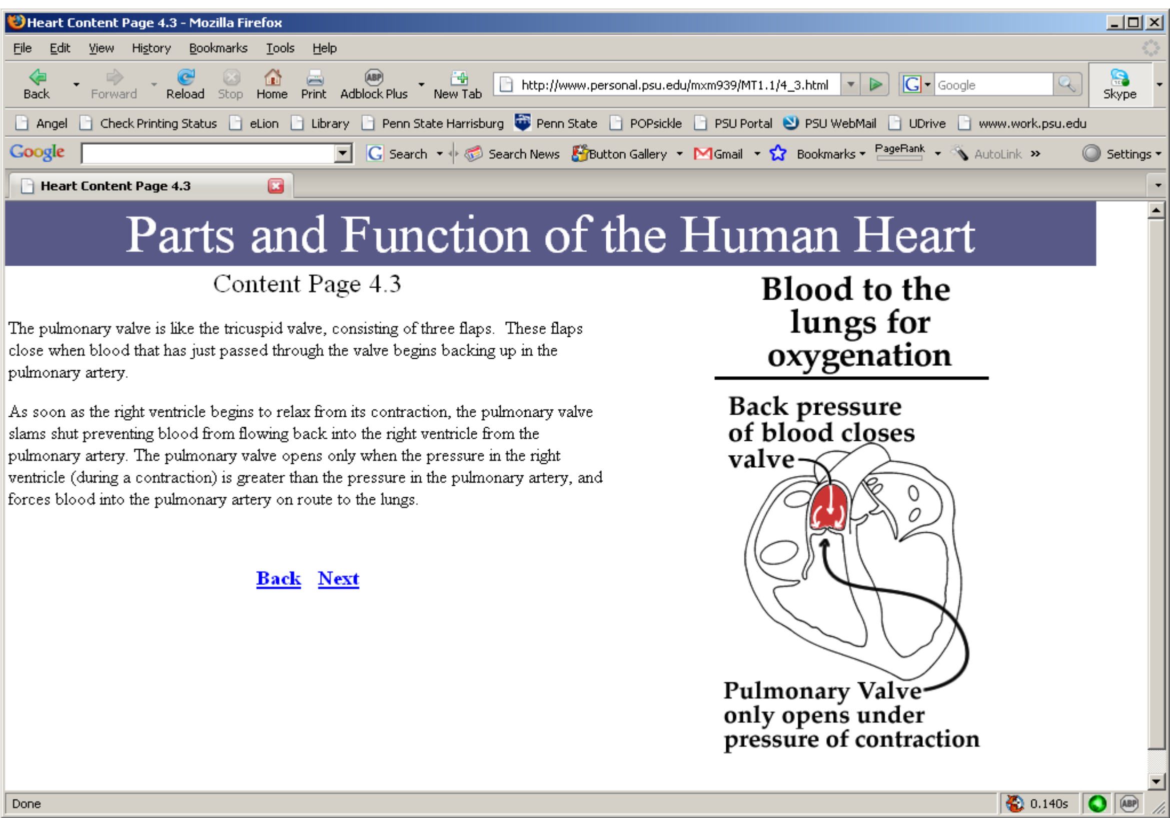
Heart Content Page 4.2 - Mozilla Firefox

Parts and Function of the Human Heart

Content Page 4.2

While the blood pressure behind the flaps of the tricuspid valve increases it brings the flaps together and prevents the flow of blood back into the right auricle. The contraction of the right ventricle continues until the blood presses hard enough to open the pulmonary valve and to force the blood into the pulmonary artery. The pulmonary valve is located between the right ventricle and the pulmonary artery.

Back Next



Heart Content Page 4.3 - Mozilla Firefox

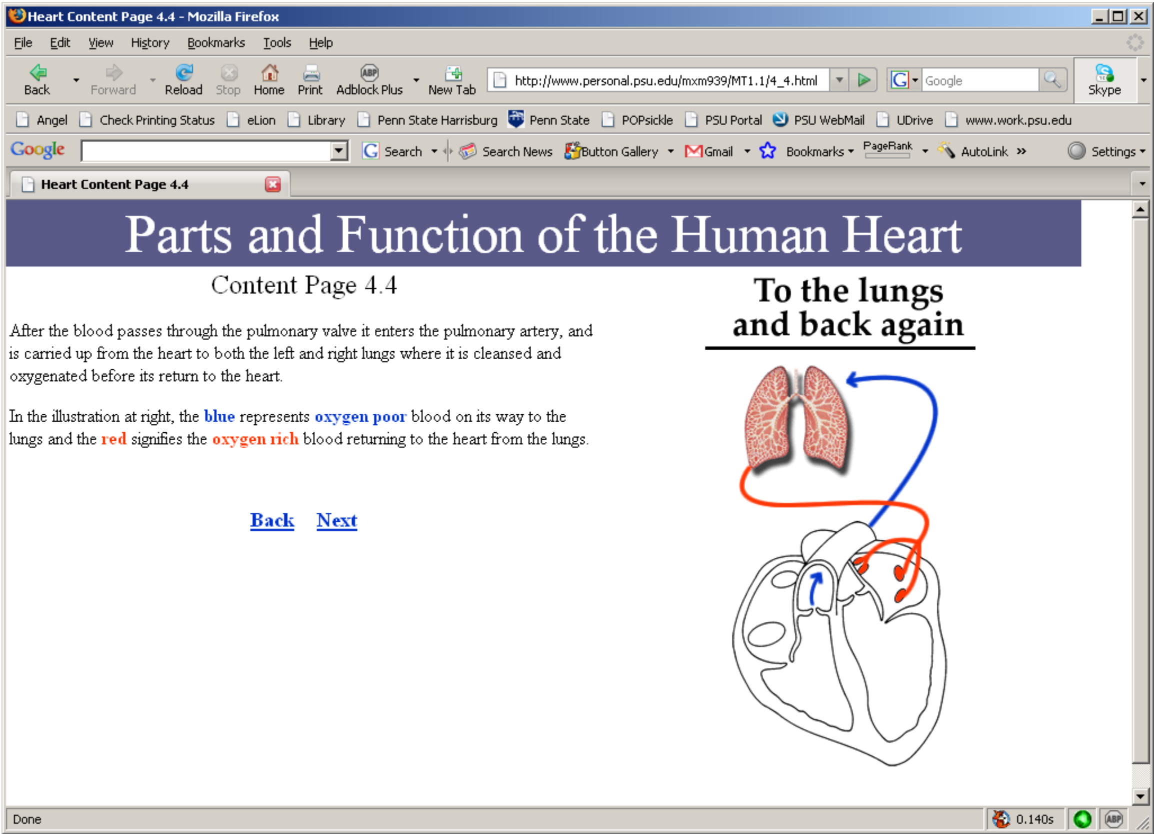
Parts and Function of the Human Heart

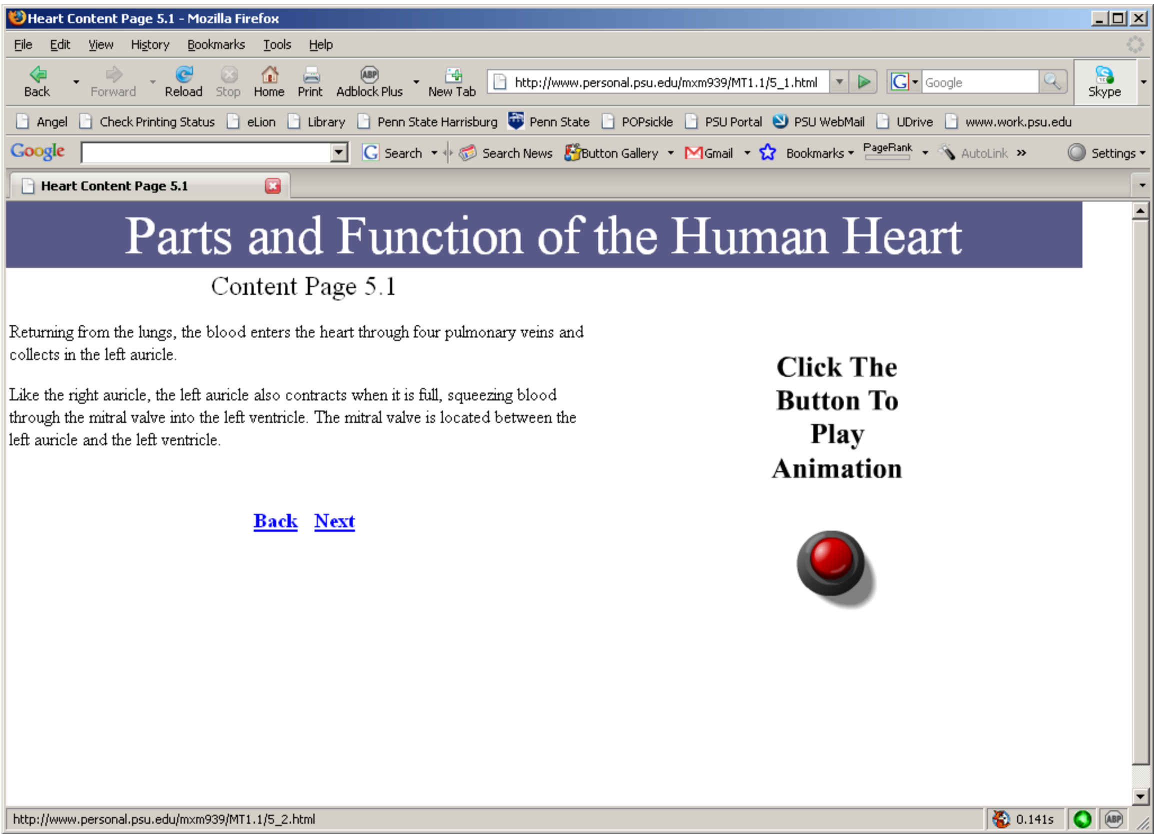
Content Page 4.3

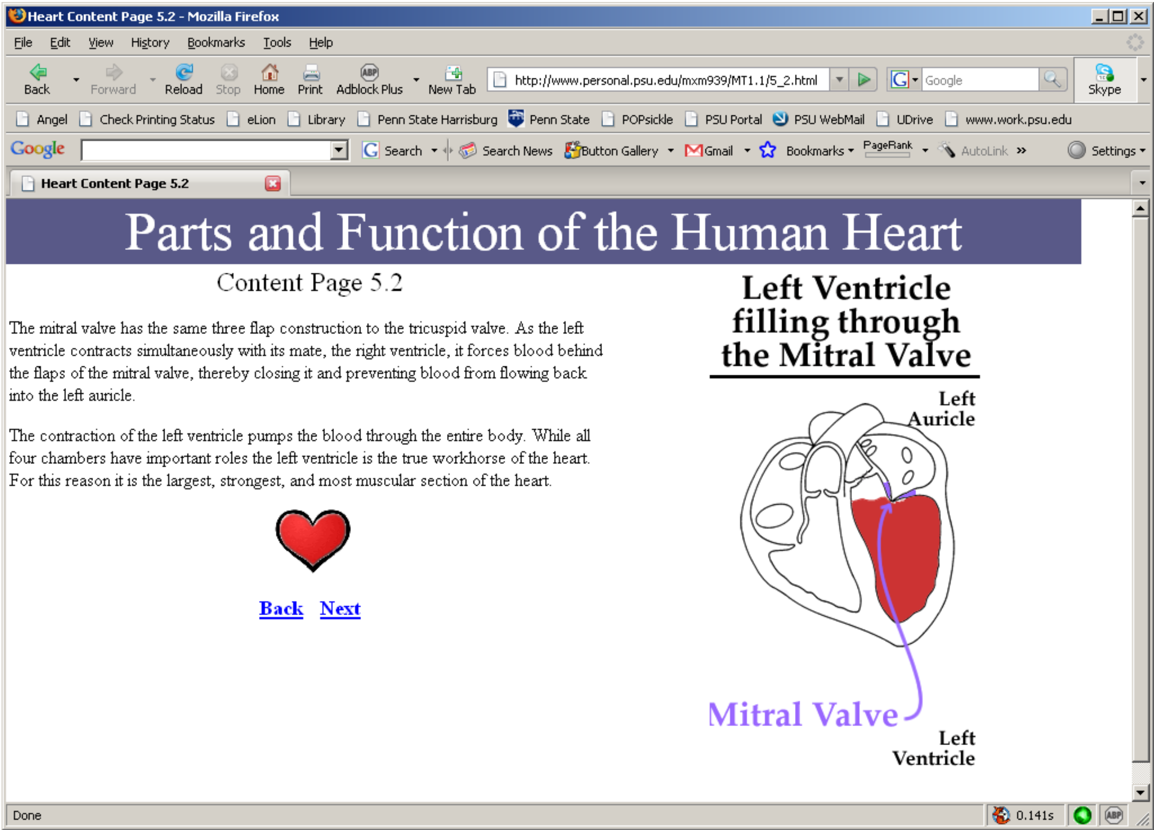
The pulmonary valve is like the tricuspid valve, consisting of three flaps. These flaps close when blood that has just passed through the valve begins backing up in the pulmonary artery.

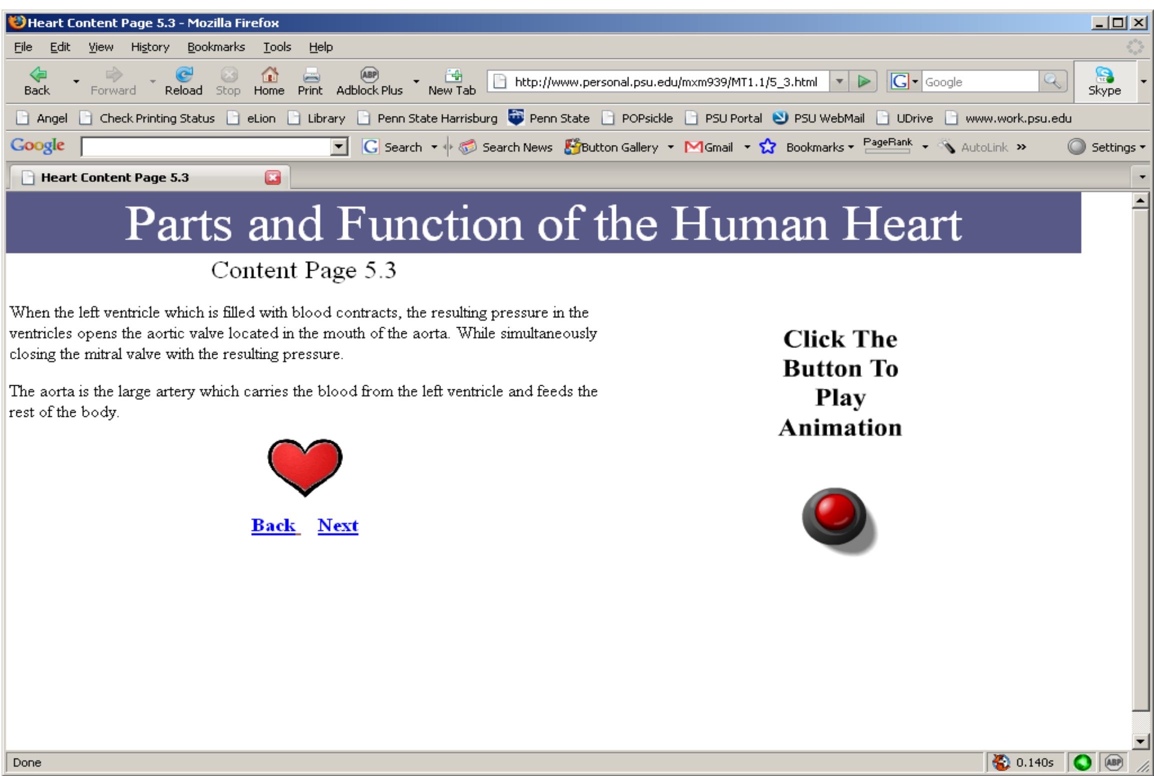
As soon as the right ventricle begins to relax from its contraction, the pulmonary valve slams shut preventing blood from flowing back into the right ventricle from the pulmonary artery. The pulmonary valve opens only when the pressure in the right ventricle (during a contraction) is greater than the pressure in the pulmonary artery, and forces blood into the pulmonary artery on route to the lungs.

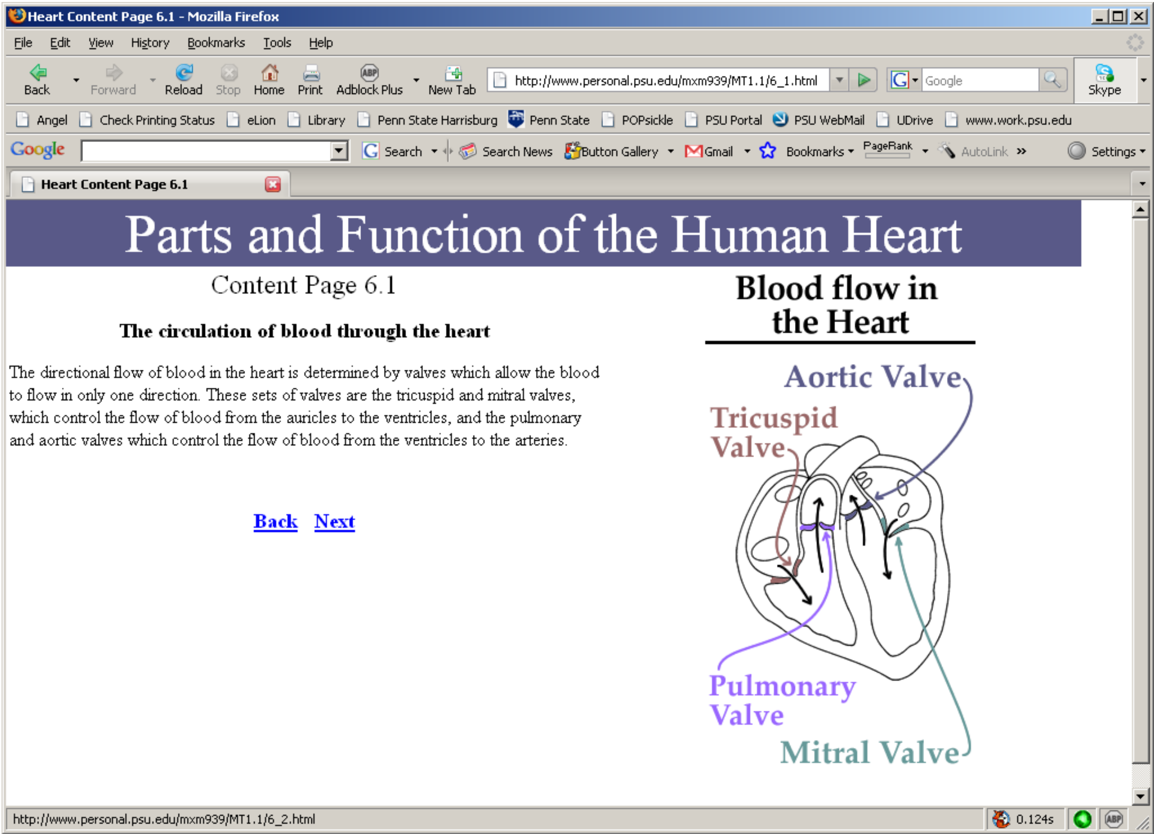
Back Next

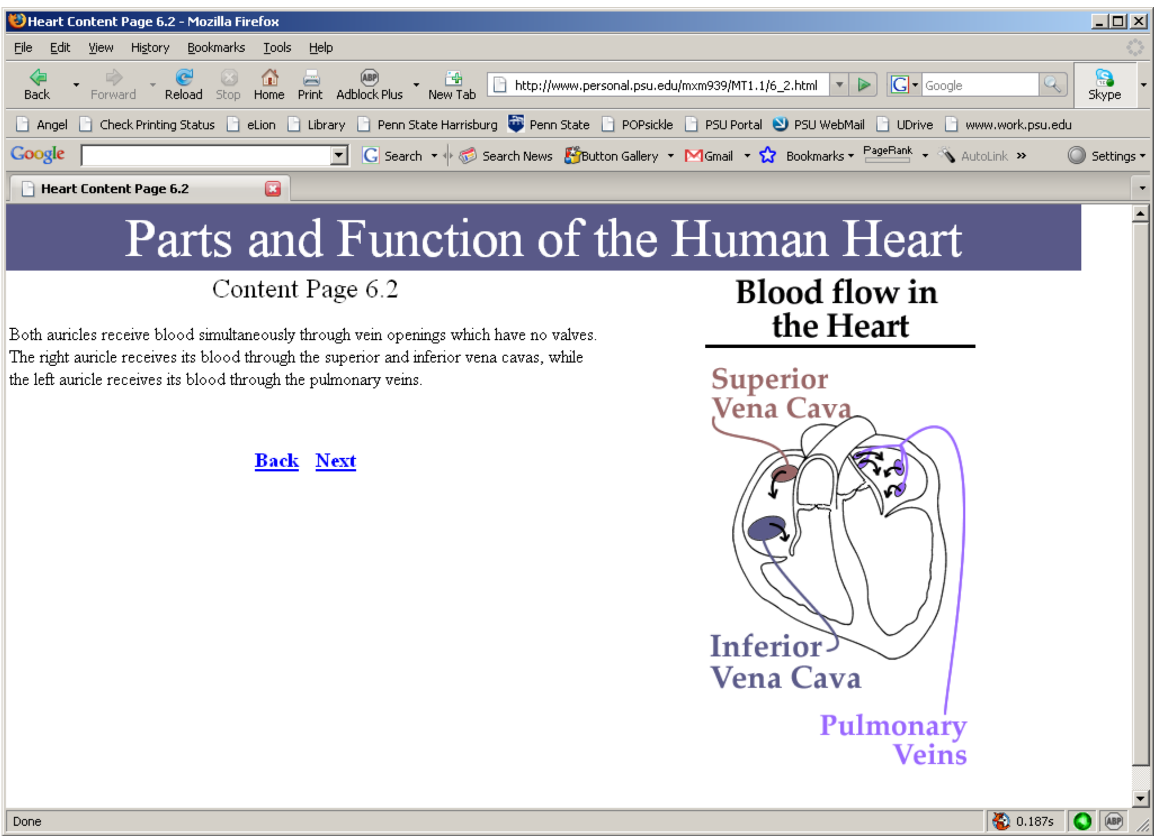

Heart Content Page 4.4 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/4_4.html
Parts and Function of the Human Heart
Content Page 4.4
After the blood passes through the pulmonary valve it enters the pulmonary artery, and is carried up from the heart to both the left and right lungs where it is cleansed and oxygenated before its return to the heart.
In the illustration at right, the blue represents oxygen poor blood on its way to the lungs and the red signifies the oxygen rich blood returning to the heart from the lungs.
Back Next
To the lungs
and back again
Done

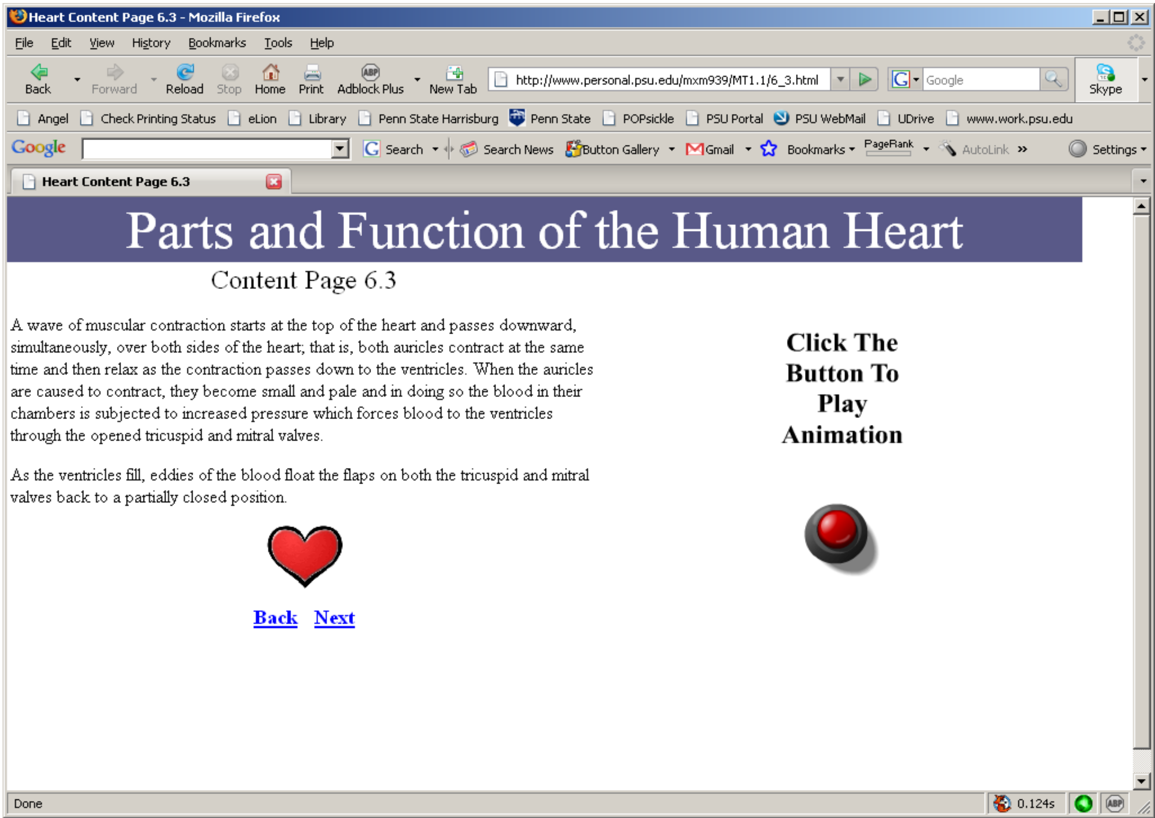

Heart Content Page 5.1 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/5_1.html
Parts and Function of the Human Heart
Content Page 5.1
Returning from the lungs, the blood enters the heart through four pulmonary veins and collects in the left auricle.
Like the right auricle, the left auricle also contracts when it is full, squeezing blood through the mitral valve into the left ventricle. The mitral valve is located between the left auricle and the left ventricle.
Back Next
Click The
Button To
Play
Animation
http://www.personal.psu.edu/mxm939/MT1.1/5_2.html

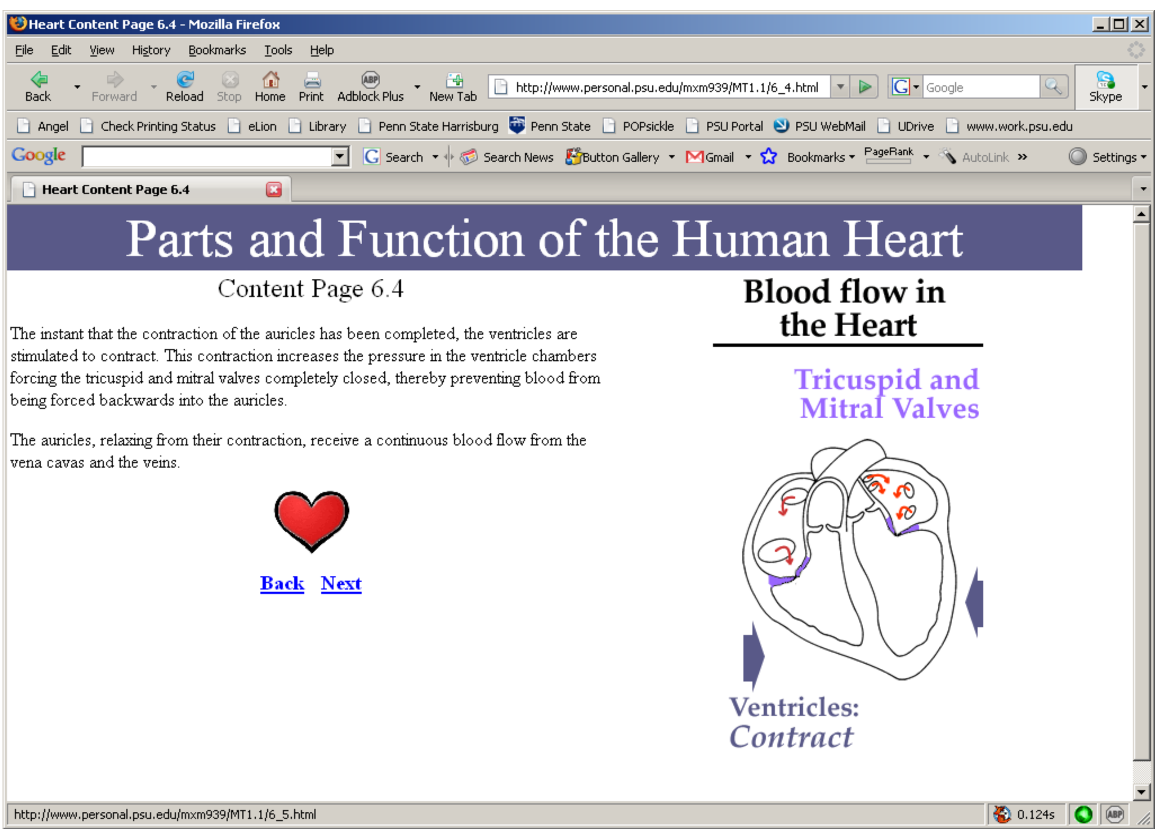

Heart Content Page 5.2 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/5_2.html
Parts and Function of the Human Heart
Content Page 5.2
The mitral valve has the same three flap construction to the tricuspid valve. As the left ventricle contracts simultaneously with its mate, the right ventricle, it forces blood behind the flaps of the mitral valve, thereby closing it and preventing blood from flowing back into the left auricle.
The contraction of the left ventricle pumps the blood through the entire body. While all four chambers have important roles the left ventricle is the true workhorse of the heart. For this reason it is the largest, strongest, and most muscular section of the heart.
Back Next
Left Ventricle filling through the Mitral Valve
Left Auricle
Mitral Valve
Left Ventricle
Done

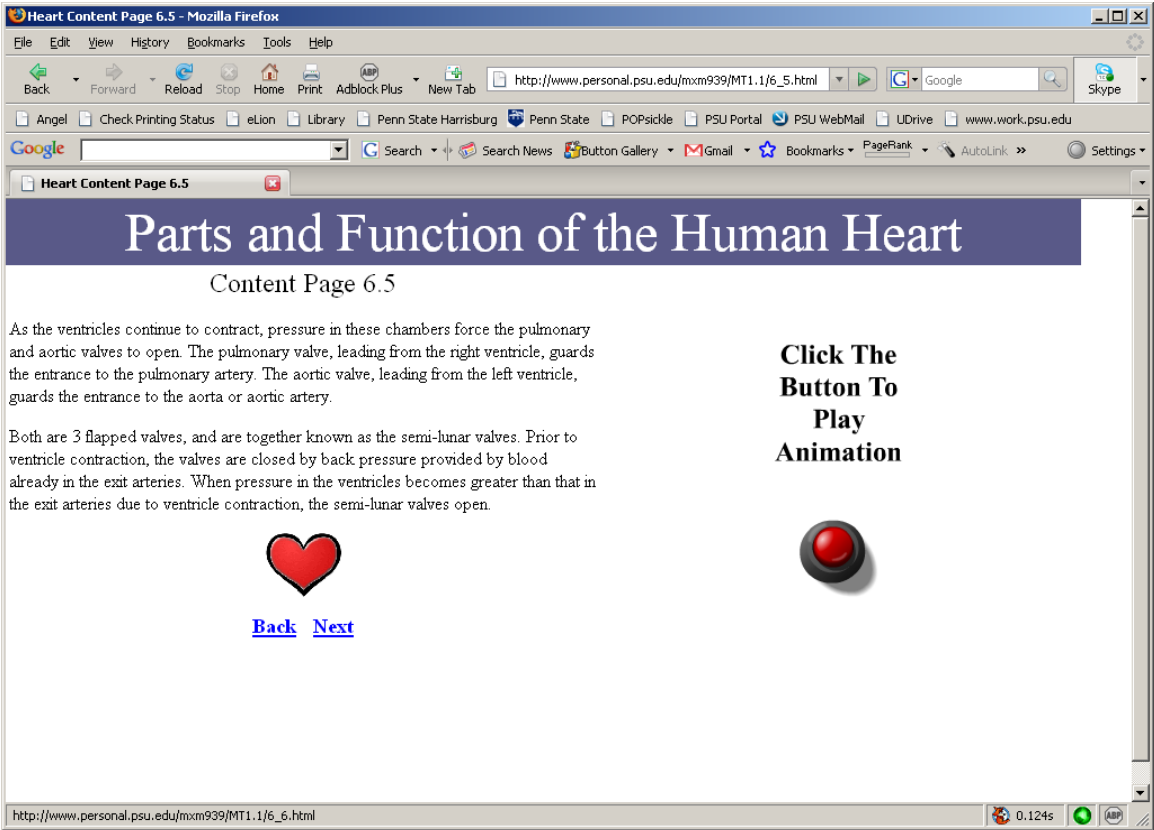

Heart Content Page 5.3 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/5_3.html
Parts and Function of the Human Heart
Content Page 5.3
When the left ventricle which is filled with blood contracts, the resulting pressure in the ventricles opens the aortic valve located in the mouth of the aorta. While simultaneously closing the mitral valve with the resulting pressure.
The aorta is the large artery which carries the blood from the left ventricle and feeds the rest of the body.
Back Next
Click The Button To Play Animation
Done


Heart Content Page 6.1 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/6_1.html
Parts and Function of the Human Heart
Content Page 6.1
The circulation of blood through the heart
The directional flow of blood in the heart is determined by valves which allow the blood to flow in only one direction. These sets of valves are the tricuspid and mitral valves, which control the flow of blood from the auricles to the ventricles, and the pulmonary and aortic valves which control the flow of blood from the ventricles to the arteries.
Back Next
Blood flow in the Heart
Aortic Valve
Tricuspid Valve
Pulmonary Valve
Mitral Valve
http://www.personal.psu.edu/mxm939/MT1.1/6_2.html


Heart Content Page 6.2 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/6_2.html
Parts and Function of the Human Heart
Content Page 6.2
Both auricles receive blood simultaneously through vein openings which have no valves. The right auricle receives its blood through the superior and inferior vena cavas, while the left auricle receives its blood through the pulmonary veins.
Back Next
Blood flow in the Heart
Superior Vena Cava
Inferior Vena Cava
Pulmonary Veins
Done


Heart Content Page 6.3 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/6_3.html
Parts and Function of the Human Heart
Content Page 6.3
A wave of muscular contraction starts at the top of the heart and passes downward, simultaneously, over both sides of the heart; that is, both auricles contract at the same time and then relax as the contraction passes down to the ventricles. When the auricles are caused to contract, they become small and pale and in doing so the blood in their chambers is subjected to increased pressure which forces blood to the ventricles through the opened tricuspid and mitral valves.
As the ventricles fill, eddies of the blood float the flaps on both the tricuspid and mitral valves back to a partially closed position.
Back Next
Click The Button To Play Animation
Done


Heart Content Page 6.4 - Mozilla Firefox
http://www.personal.psu.edu/mxm939/MT1.1/6_4.html
Parts and Function of the Human Heart
Content Page 6.4
The instant that the contraction of the auricles has been completed, the ventricles are stimulated to contract. This contraction increases the pressure in the ventricle chambers forcing the tricuspid and mitral valves completely closed, thereby preventing blood from being forced backwards into the auricles.
The auricles, relaxing from their contraction, receive a continuous blood flow from the vena cavas and the veins.
Back Next
Blood flow in the Heart
Tricuspid and Mitral Valves
Ventricles:
Contract
http://www.personal.psu.edu/mxm939/MT1.1/6_5.html



Heart Content Page 6.5 - Mozilla Firefox

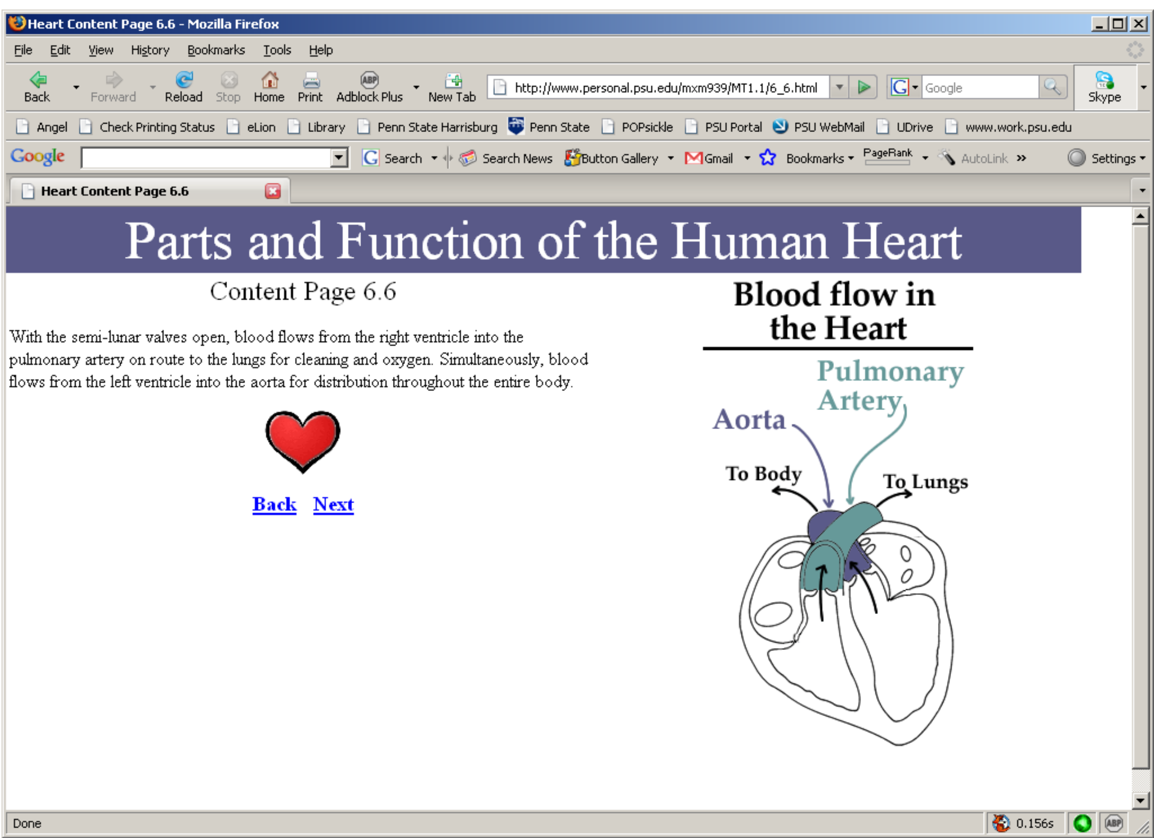
Parts and Function of the Human Heart

Content Page 6.5

As the ventricles continue to contract, pressure in these chambers force the pulmonary and aortic valves to open. The pulmonary valve, leading from the right ventricle, guards the entrance to the pulmonary artery. The aortic valve, leading from the left ventricle, guards the entrance to the aorta or aortic artery.

Both are 3 flapped valves, and are together known as the semi-lunar valves. Prior to ventricle contraction, the valves are closed by back pressure provided by blood already in the exit arteries. When pressure in the ventricles becomes greater than that in the exit arteries due to ventricle contraction, the semi-lunar valves open.

Back Next



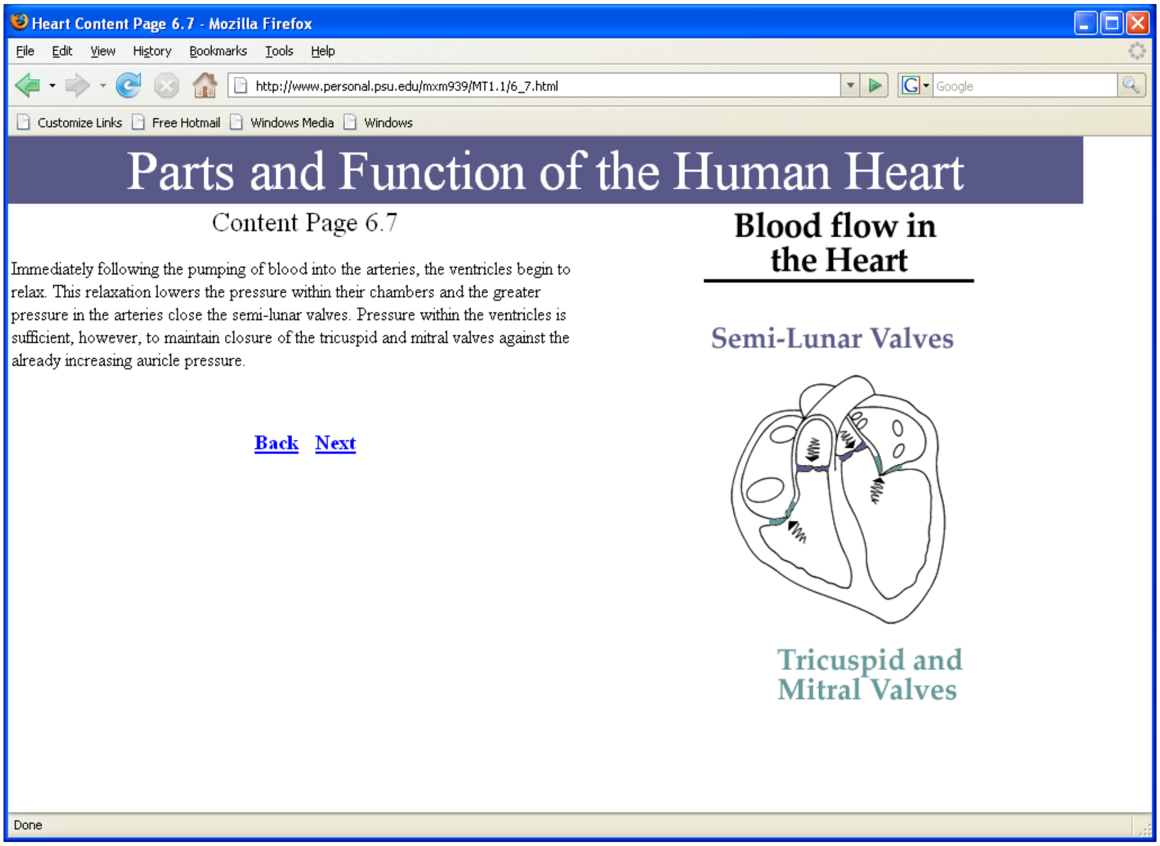
Heart Content Page 6.6 - Mozilla Firefox

Parts and Function of the Human Heart

Content Page 6.6

With the semi-lunar valves open, blood flows from the right ventricle into the pulmonary artery on route to the lungs for cleaning and oxygen. Simultaneously, blood flows from the left ventricle into the aorta for distribution throughout the entire body.

Back Next


Heart Content Page 6.7 - Mozilla Firefox

http://www.personal.psu.edu/mxm939/MT1.1/6_7.html

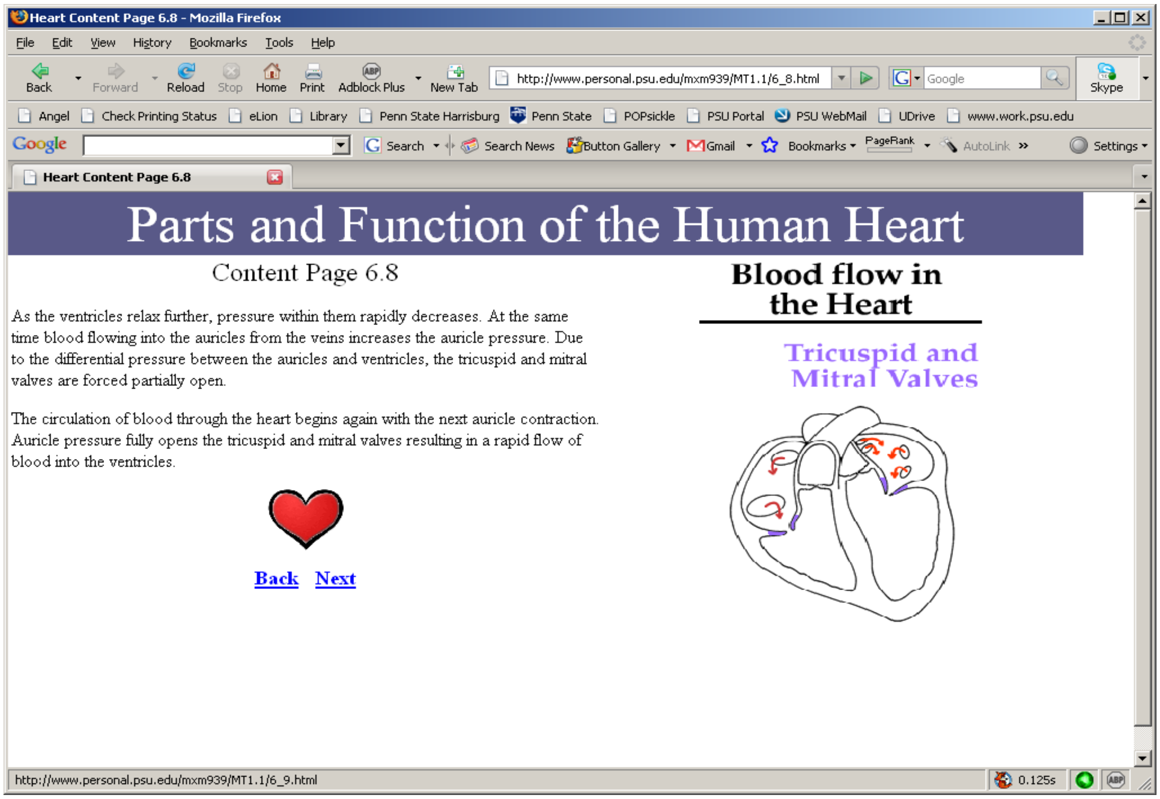
Parts and Function of the Human Heart

Content Page 6.7

Immediately following the pumping of blood into the arteries, the ventricles begin to relax. This relaxation lowers the pressure within their chambers and the greater pressure in the arteries close the semi-lunar valves. Pressure within the ventricles is sufficient, however, to maintain closure of the tricuspid and mitral valves against the already increasing auricle pressure.

Back Next

Done


Heart Content Page 6.8 - Mozilla Firefox

http://www.personal.psu.edu/mxm939/MT1.1/6_8.html

Parts and Function of the Human Heart

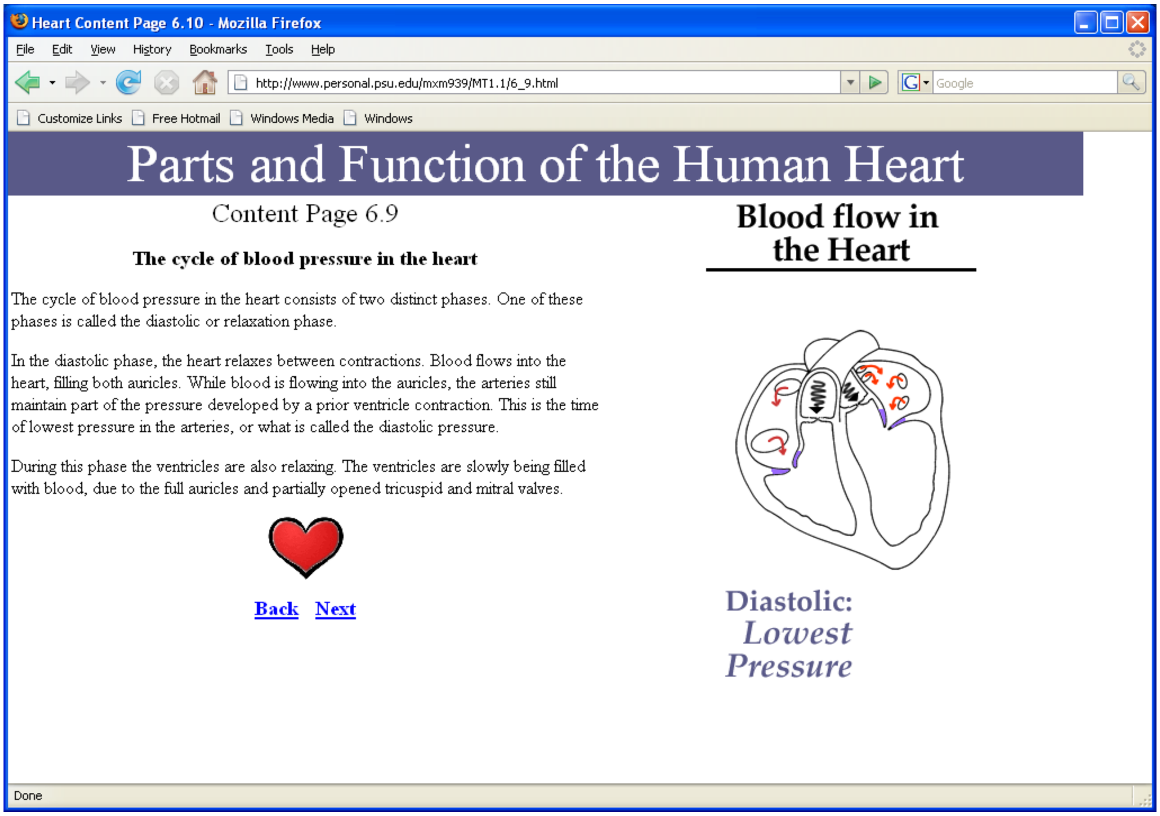
Content Page 6.8

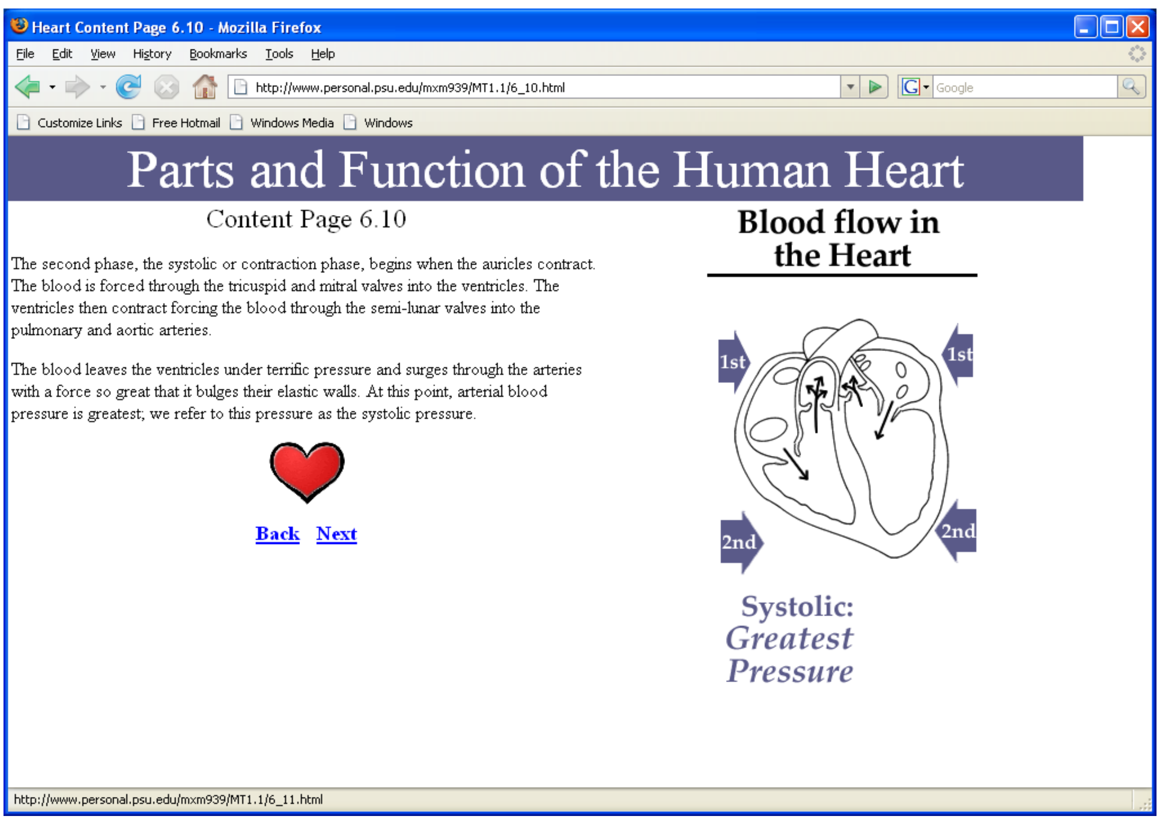
As the ventricles relax further, pressure within them rapidly decreases. At the same time blood flowing into the auricles from the veins increases the auricle pressure. Due to the differential pressure between the auricles and ventricles, the tricuspid and mitral valves are forced partially open.

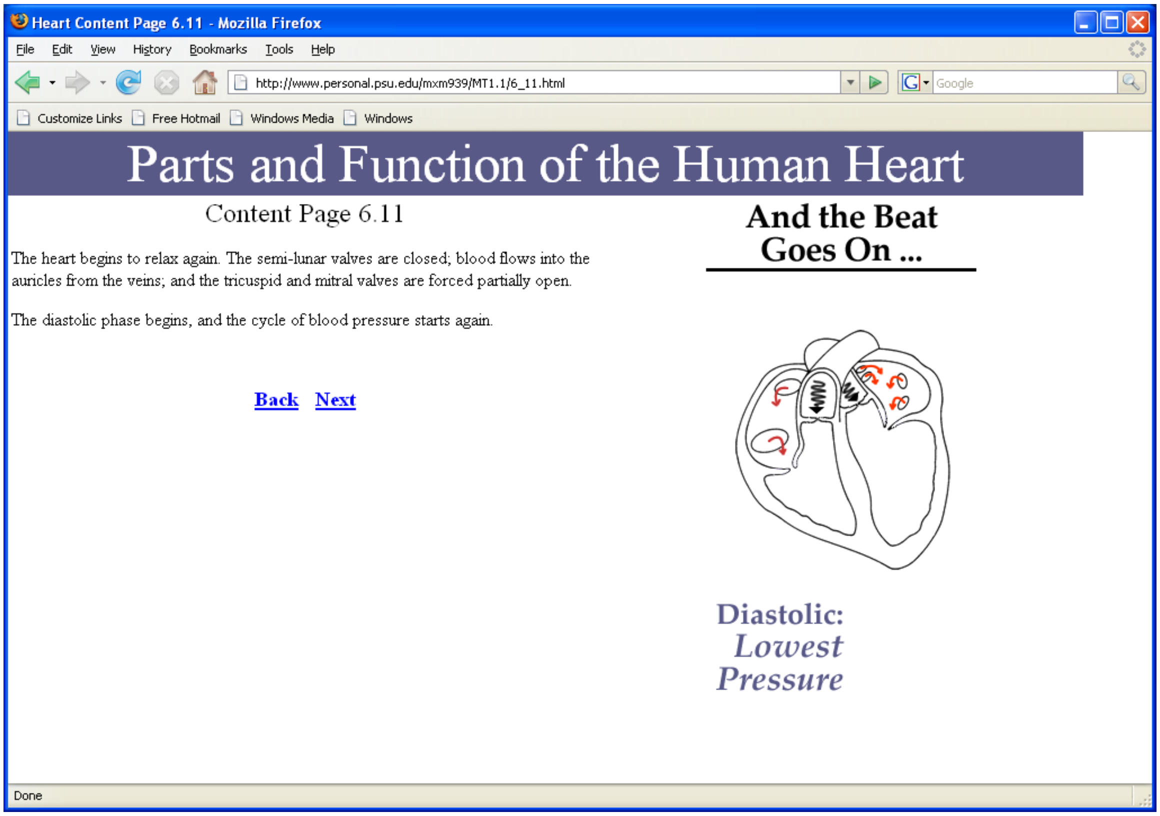
The circulation of blood through the heart begins again with the next auricle contraction. Auricle pressure fully opens the tricuspid and mitral valves resulting in a rapid flow of blood into the ventricles.

Back Next

http://www.personal.psu.edu/mxm939/MT1.1/6_9.html


Heart Content Page 6.10 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://www.personal.psu.edu/mxm939/MT1.1/6_9.html
Google
Customize Links Free Hotmail Windows Media Windows
Parts and Function of the Human Heart
Content Page 6.9
The cycle of blood pressure in the heart
The cycle of blood pressure in the heart consists of two distinct phases. One of these phases is called the diastolic or relaxation phase.
In the diastolic phase, the heart relaxes between contractions. Blood flows into the heart, filling both auricles. While blood is flowing into the auricles, the arteries still maintain part of the pressure developed by a prior ventricle contraction. This is the time of lowest pressure in the arteries, or what is called the diastolic pressure.
During this phase the ventricles are also relaxing. The ventricles are slowly being filled with blood, due to the full auricles and partially opened tricuspid and mitral valves.
Back Next
Blood flow in the Heart
Diastolic: Lowest Pressure
Done


Heart Content Page 6.10 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://www.personal.psu.edu/mxm939/MT1.1/6_10.html
Google
Customize Links Free Hotmail Windows Media Windows
Parts and Function of the Human Heart
Content Page 6.10
The second phase, the systolic or contraction phase, begins when the auricles contract. The blood is forced through the tricuspid and mitral valves into the ventricles. The ventricles then contract forcing the blood through the semi-lunar valves into the pulmonary and aortic arteries.
The blood leaves the ventricles under terrific pressure and surges through the arteries with a force so great that it bulges their elastic walls. At this point, arterial blood pressure is greatest; we refer to this pressure as the systolic pressure.
Back Next
Blood flow in the Heart
1st
1st
2nd
2nd
Systolic: Greatest Pressure
http://www.personal.psu.edu/mxm939/MT1.1/6_11.html


Heart Content Page 6.11 - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.personal.psu.edu/mxm939/MT1.1/6_11.html

Customize Links Free Hotmail Windows Media Windows

Parts and Function of the Human Heart

Content Page 6.11

The heart begins to relax again. The semi-lunar valves are closed; blood flows into the auricles from the veins; and the tricuspid and mitral valves are forced partially open.

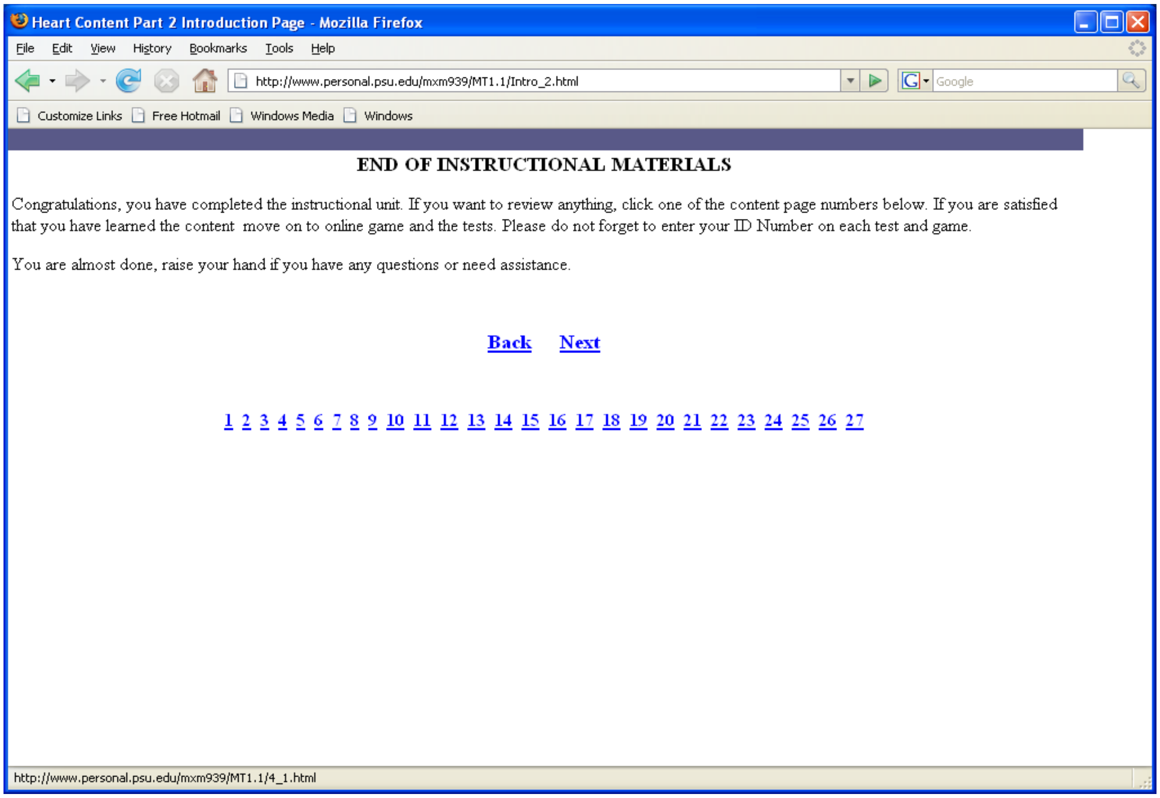
The diastolic phase begins, and the cycle of blood pressure starts again.

Back Next

And the Beat Goes On ...

Diastolic: ***Lowest Pressure***

Done


Heart Content Part 2 Introduction Page - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.personal.psu.edu/mxm939/MT1.1/Intro_2.html

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END OF INSTRUCTIONAL MATERIALS

Congratulations, you have completed the instructional unit. If you want to review anything, click one of the content page numbers below. If you are satisfied that you have learned the content move on to online game and the tests. Please do not forget to enter your ID Number on each test and game.

You are almost done, raise your hand if you have any questions or need assistance.

Back Next

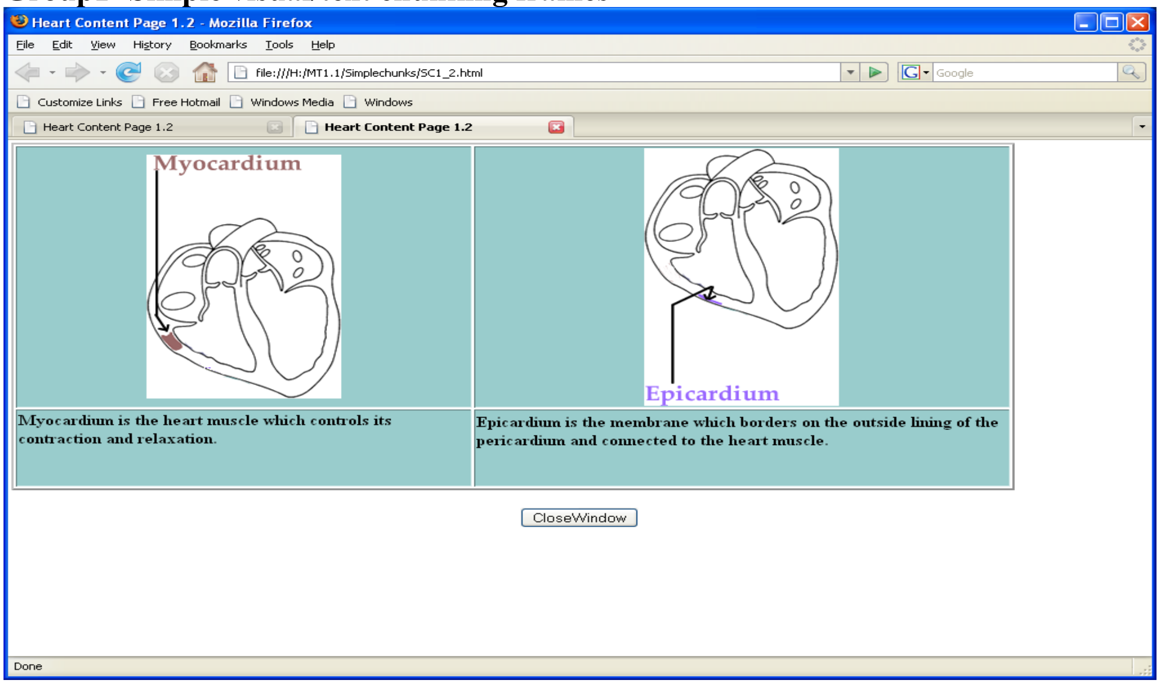
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

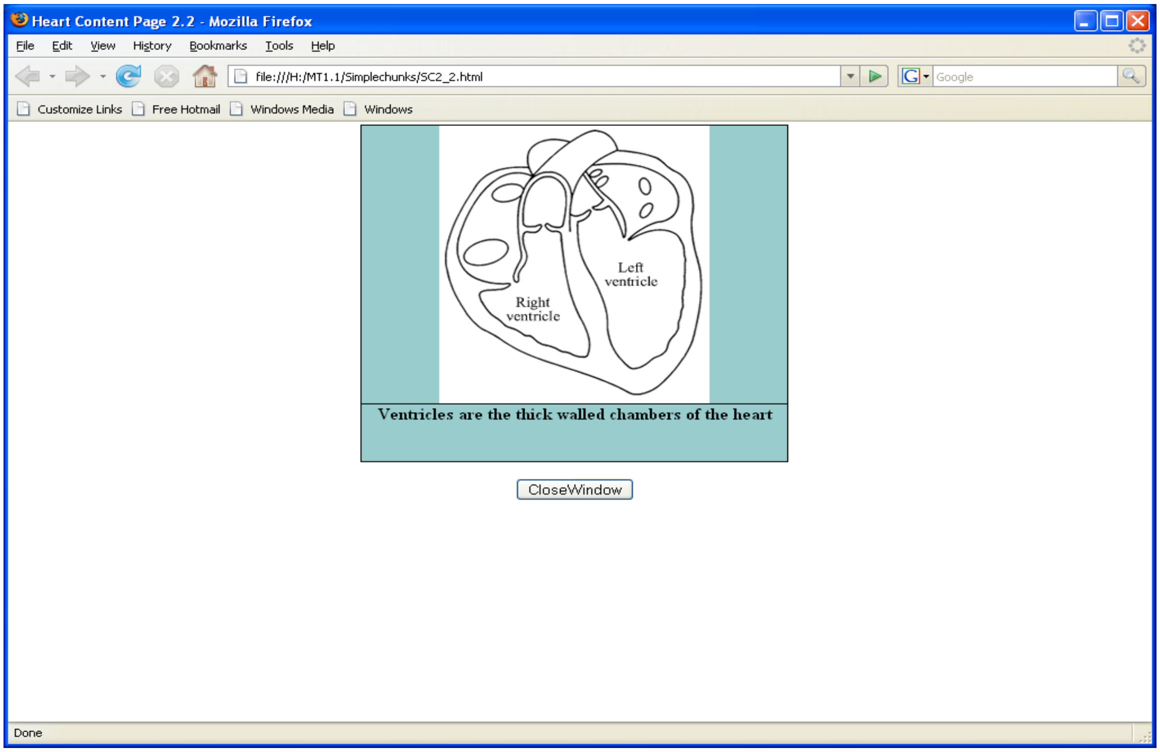
http://www.personal.psu.edu/mxm939/MT1.1/4_1.html

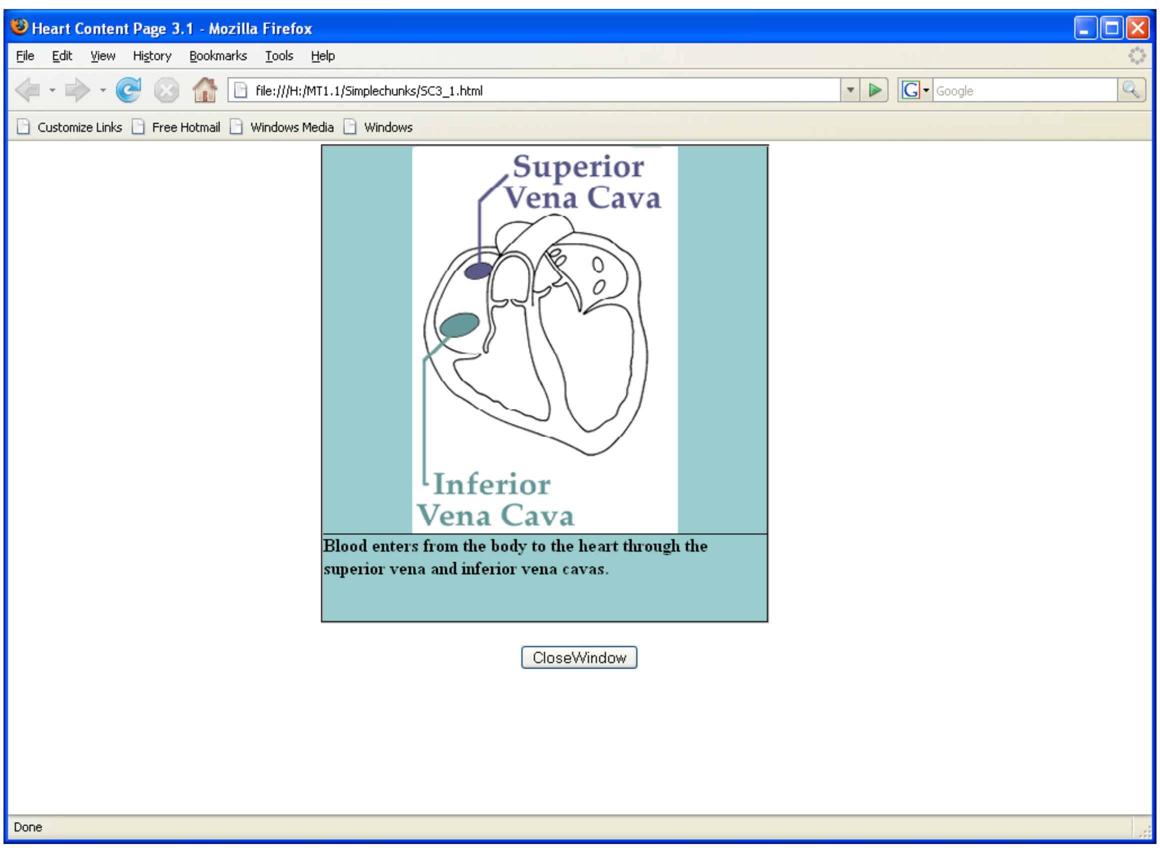
Appendix B

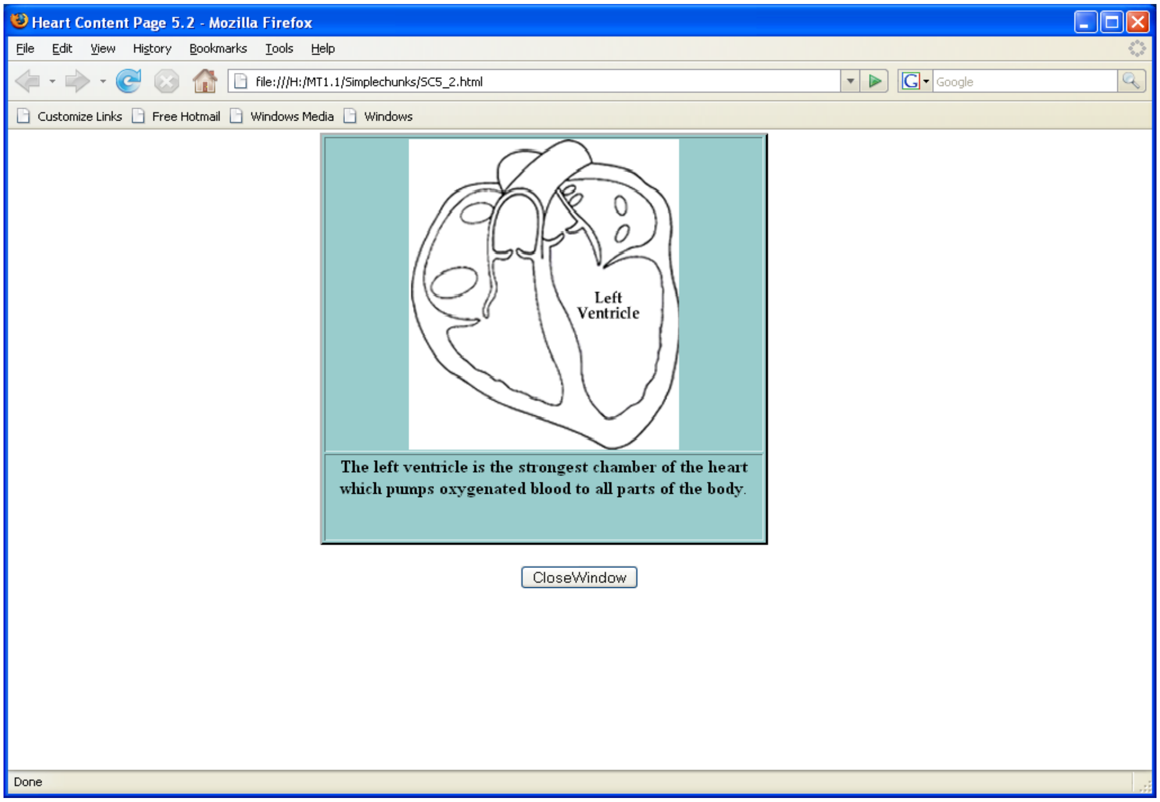
Chunking Frames

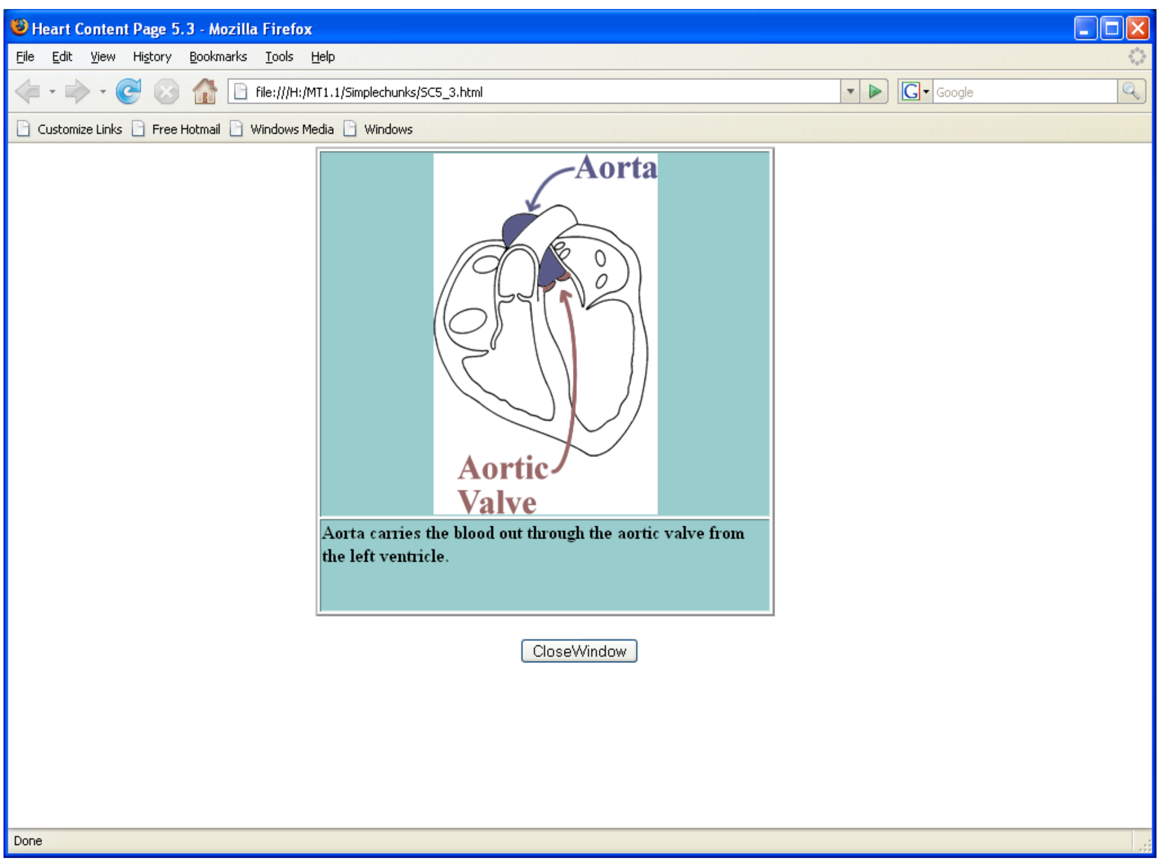
Group1- Simple visual/text chunking frames

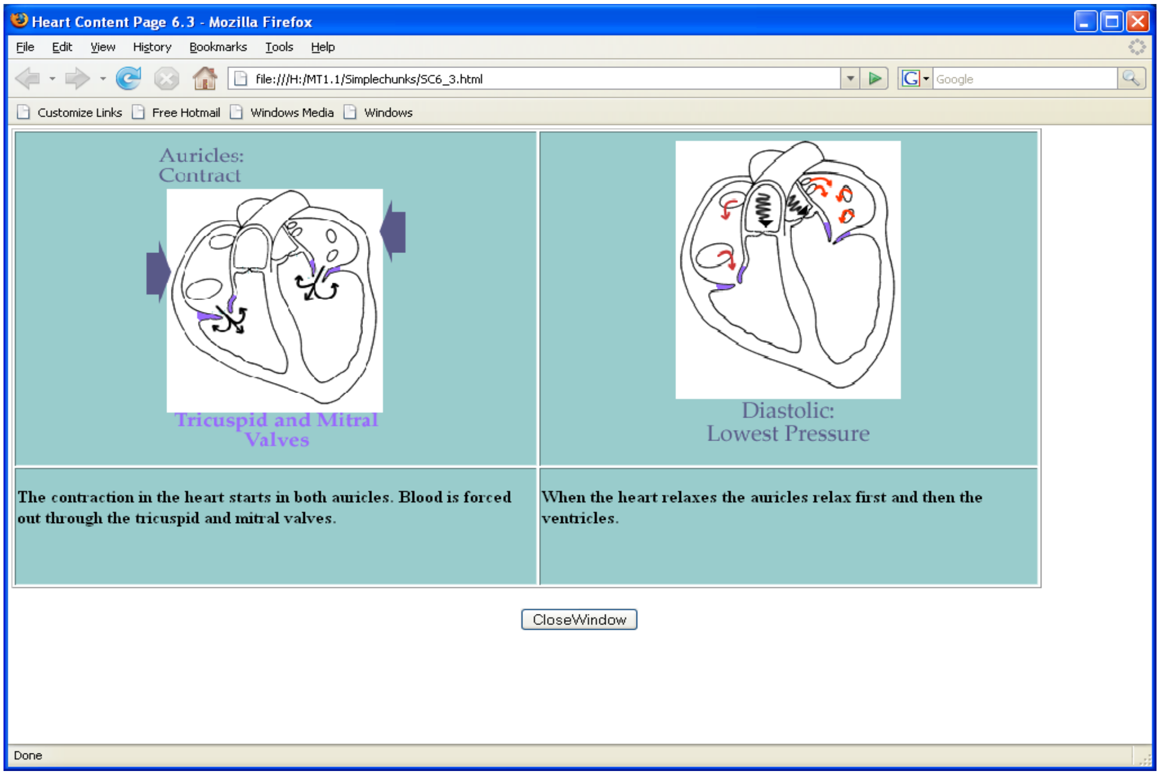


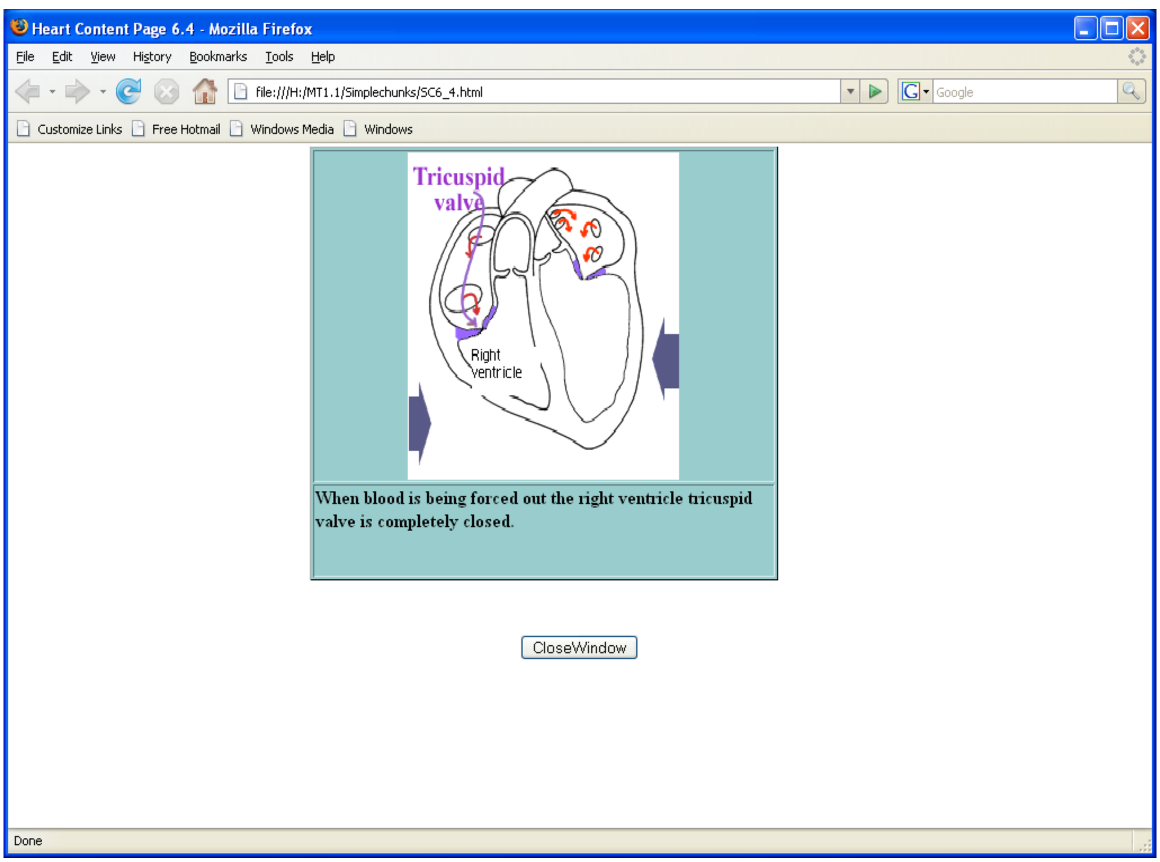

Heart Content Page 2.2 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC2_2.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Left ventricle
Right ventricle
Ventricles are the thick walled chambers of the heart
CloseWindow
Done

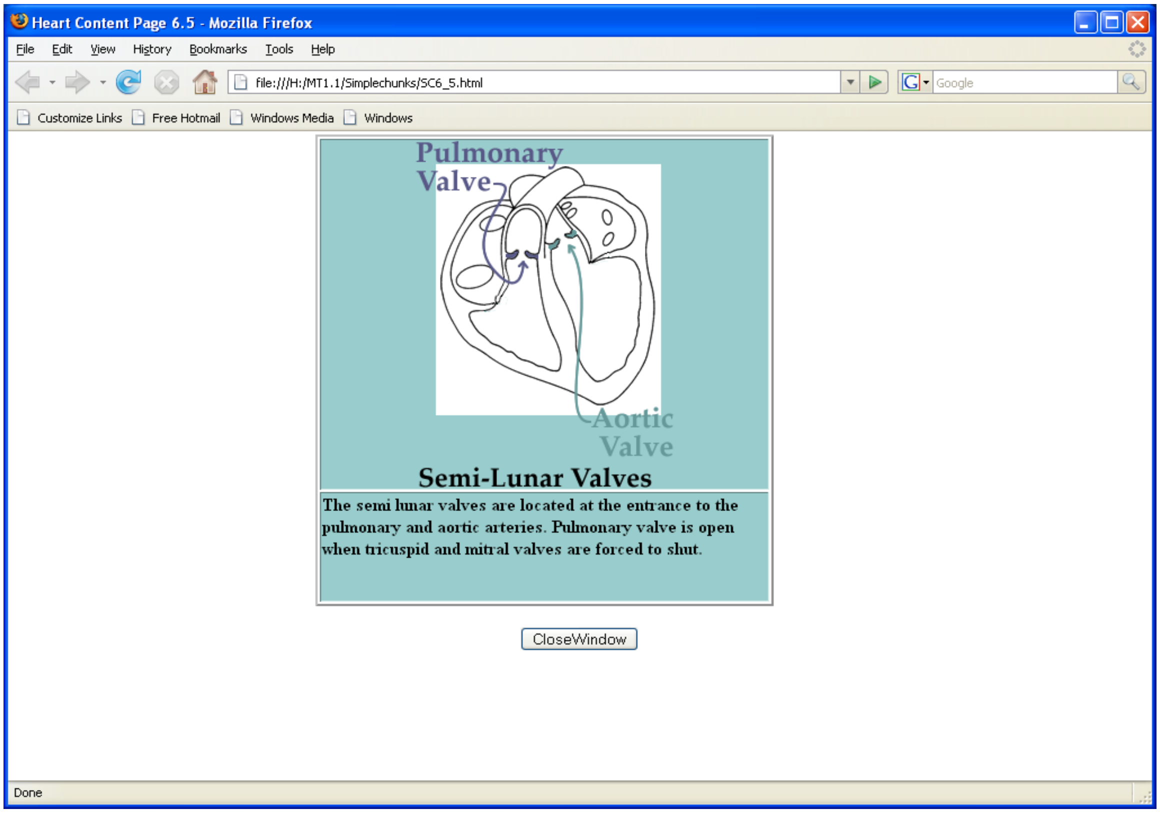

Heart Content Page 3.1 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC3_1.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Superior Vena Cava
Inferior Vena Cava
Blood enters from the body to the heart through the superior vena and inferior vena cavas.
CloseWindow
Done

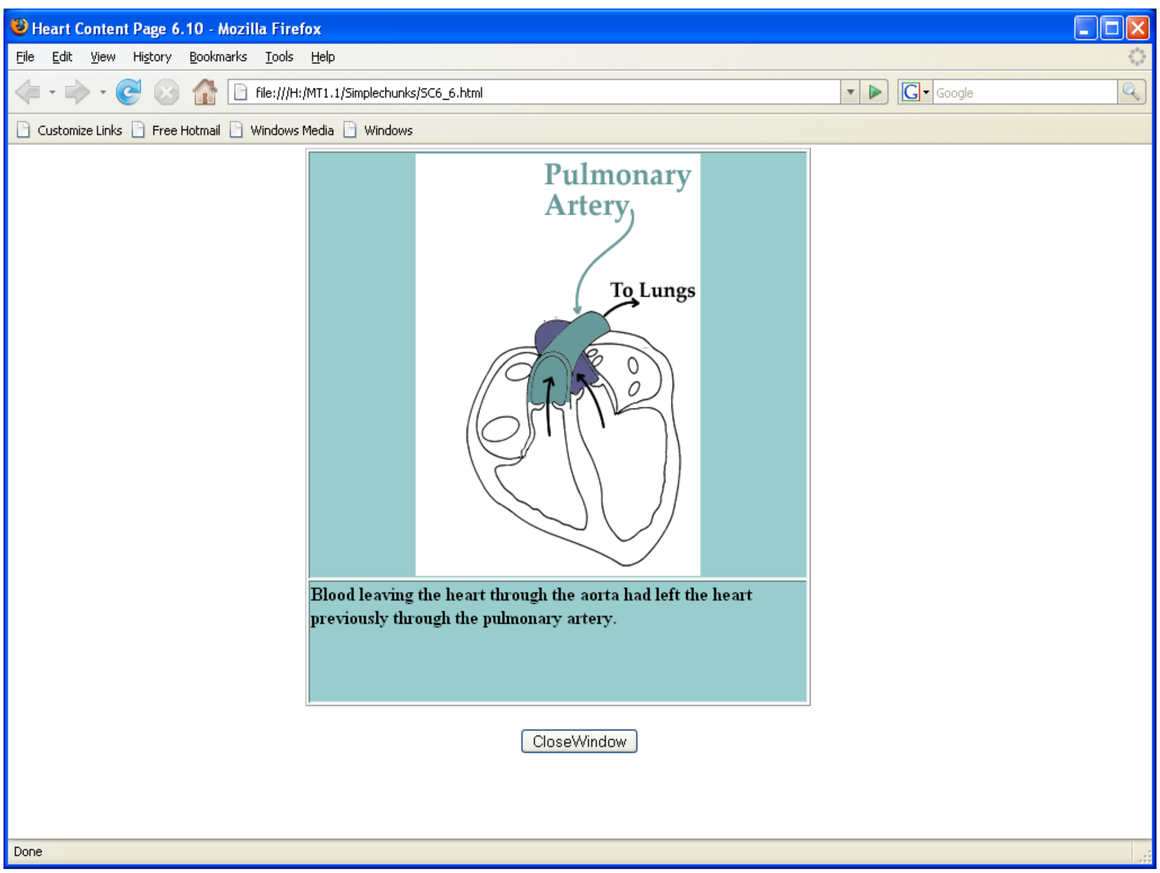

Heart Content Page 5.2 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC5_2.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Left Ventricle
The left ventricle is the strongest chamber of the heart which pumps oxygenated blood to all parts of the body.
CloseWindow
Done

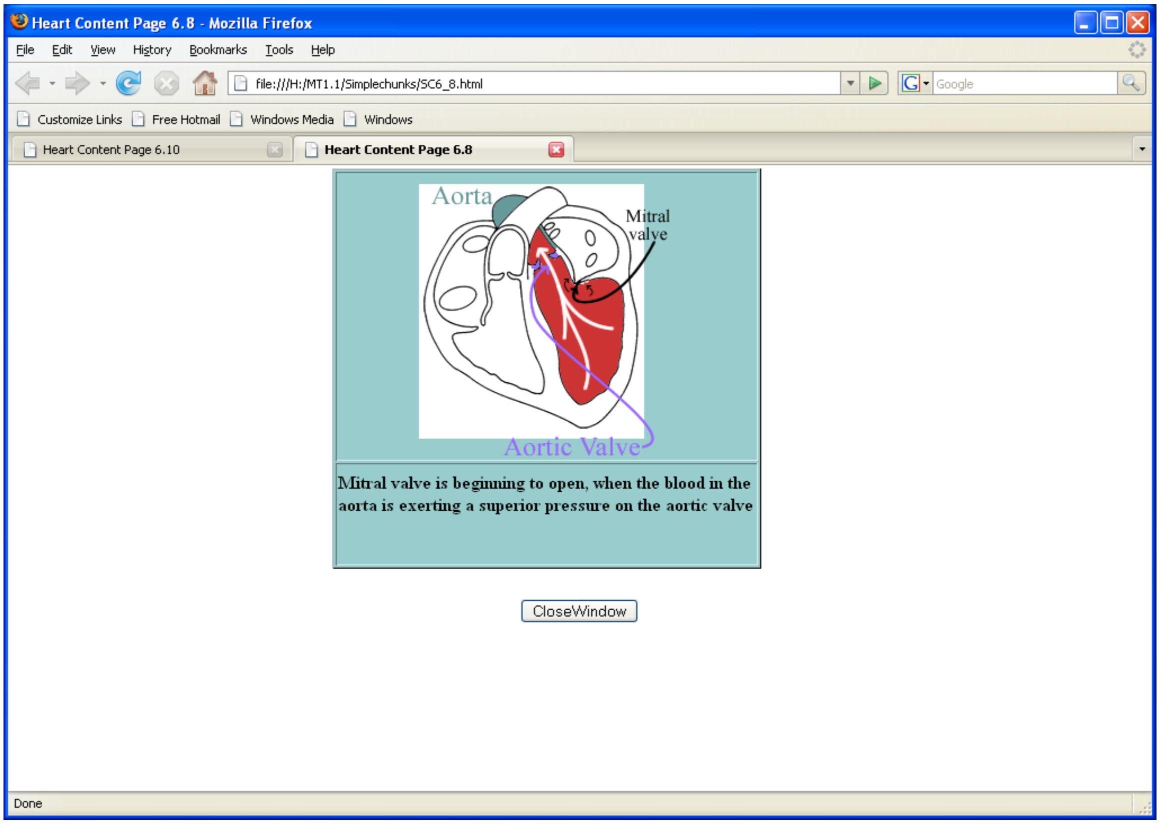

Heart Content Page 5.3 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC5_3.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Aorta
Aortic Valve
Aorta carries the blood out through the aortic valve from the left ventricle.
CloseWindow
Done

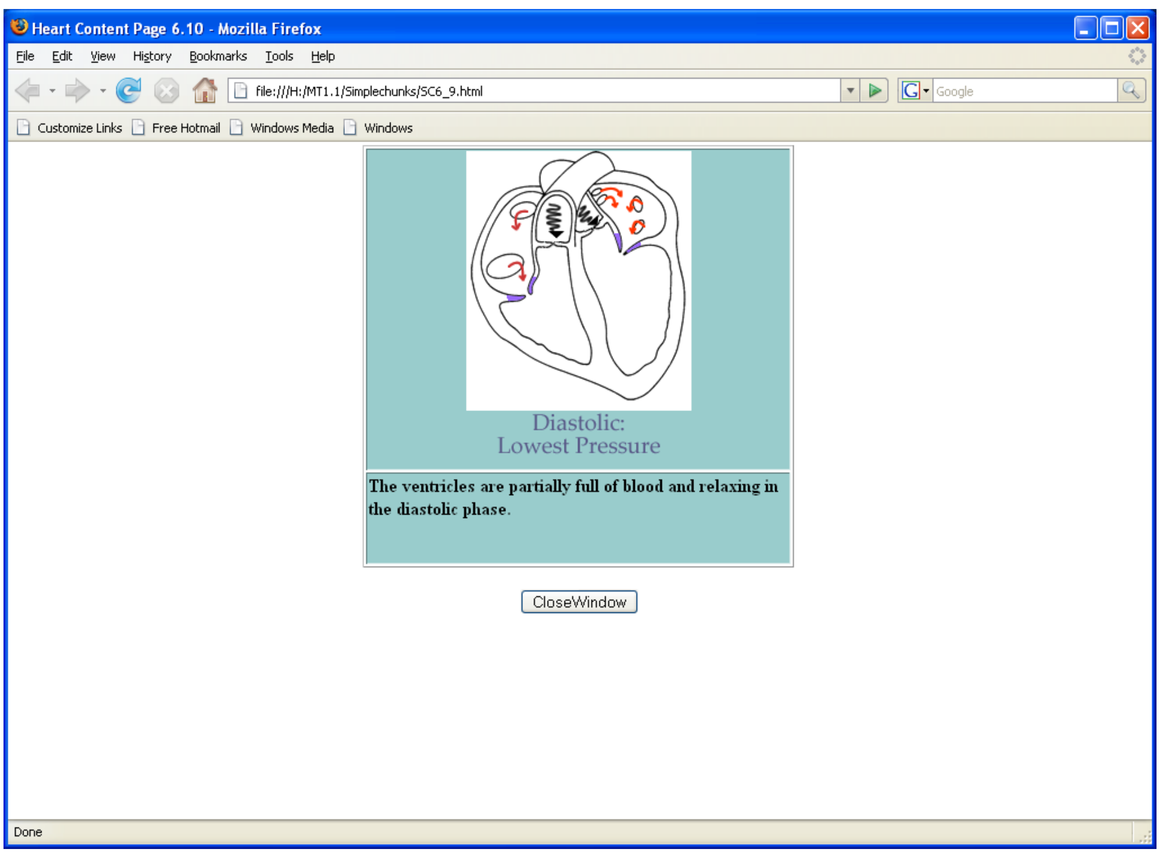

Heart Content Page 6.3 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC6_3.html
Customize Links Free Hotmail Windows Media Windows
Auricles:
Contract
Tricuspid and Mitral
Valves
Diastolic:
Lowest Pressure
The contraction in the heart starts in both auricles. Blood is forced out through the tricuspid and mitral valves.
When the heart relaxes the auricles relax first and then the ventricles.
CloseWindow
Done

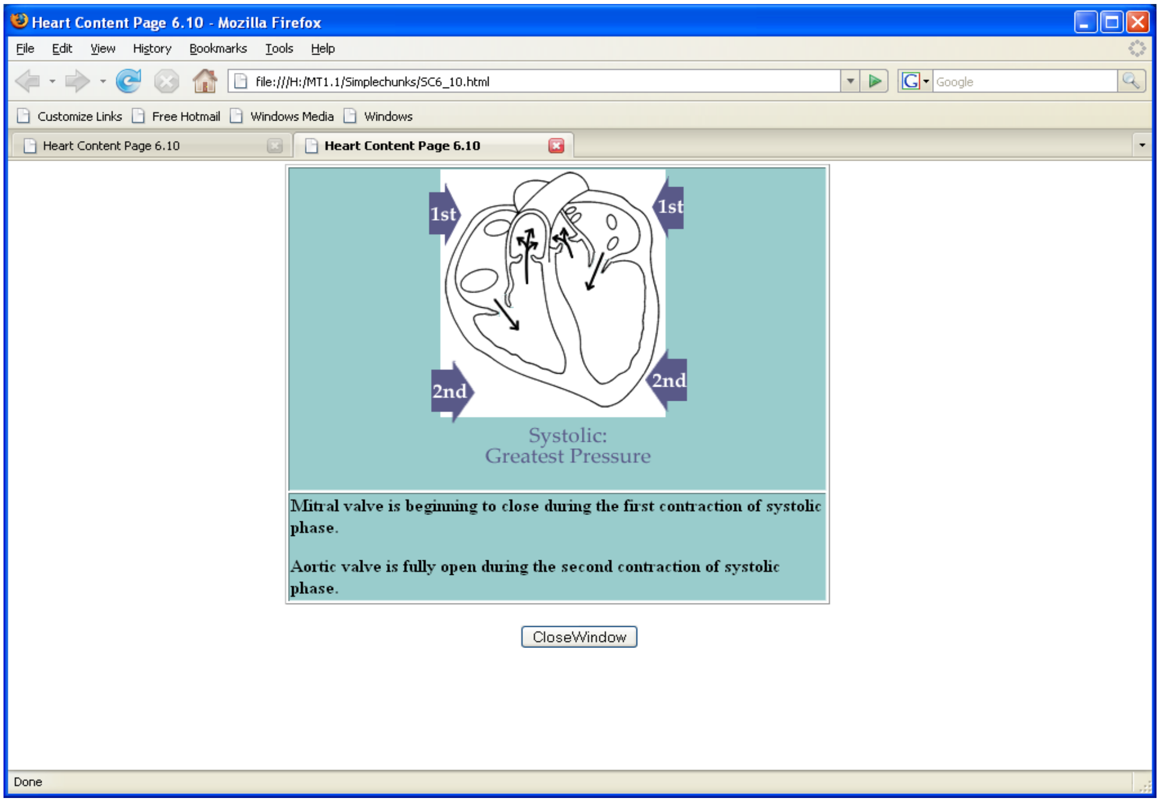

Heart Content Page 6.4 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC6_4.html
Customize Links Free Hotmail Windows Media Windows
Tricuspid
valve
Right
ventricle
When blood is being forced out the right ventricle tricuspid valve is completely closed.
CloseWindow
Done


Heart Content Page 6.5 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC6_5.html
Google
Customize Links Free Hotmail Windows Media Windows
Pulmonary Valve
Aortic Valve
Semi-Lunar Valves
The semi lunar valves are located at the entrance to the pulmonary and aortic arteries. Pulmonary valve is open when tricuspid and mitral valves are forced to shut.
CloseWindow
Done

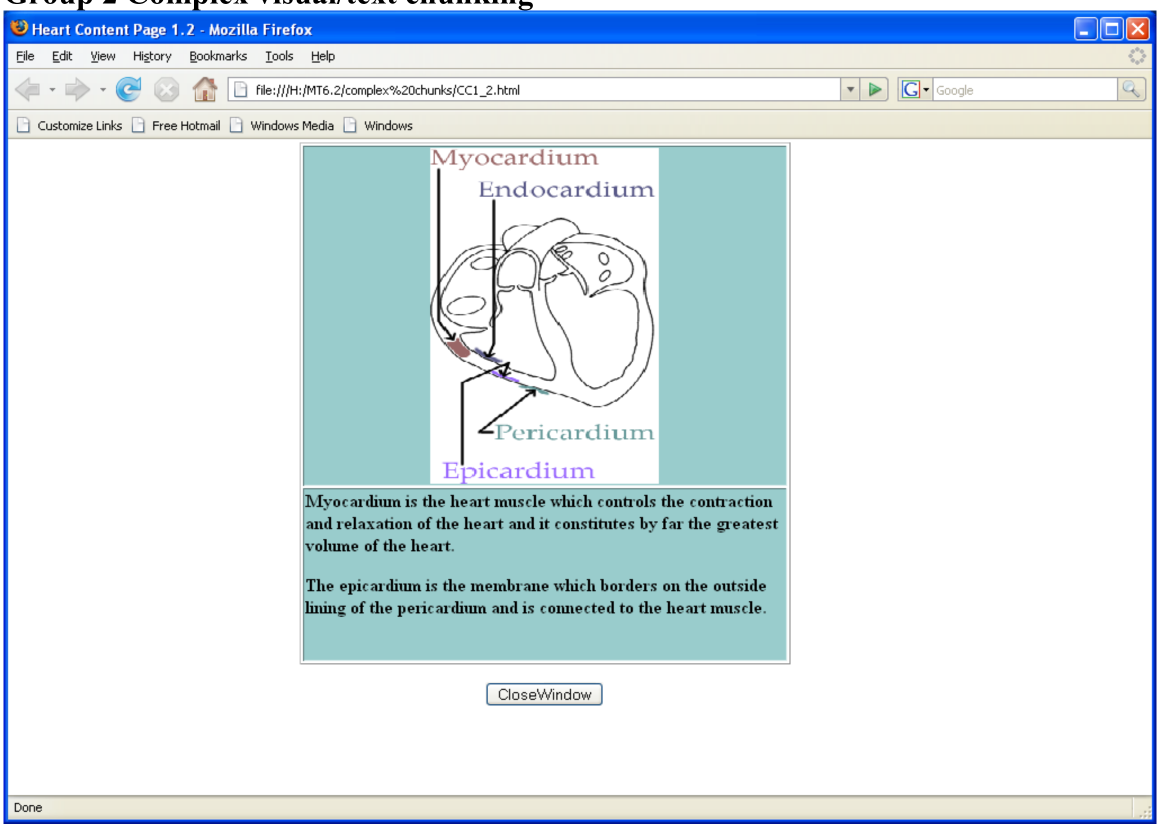

Heart Content Page 6.10 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC6_6.html
Google
Customize Links Free Hotmail Windows Media Windows
Pulmonary Artery
To Lungs
Blood leaving the heart through the aorta had left the heart previously through the pulmonary artery.
CloseWindow
Done

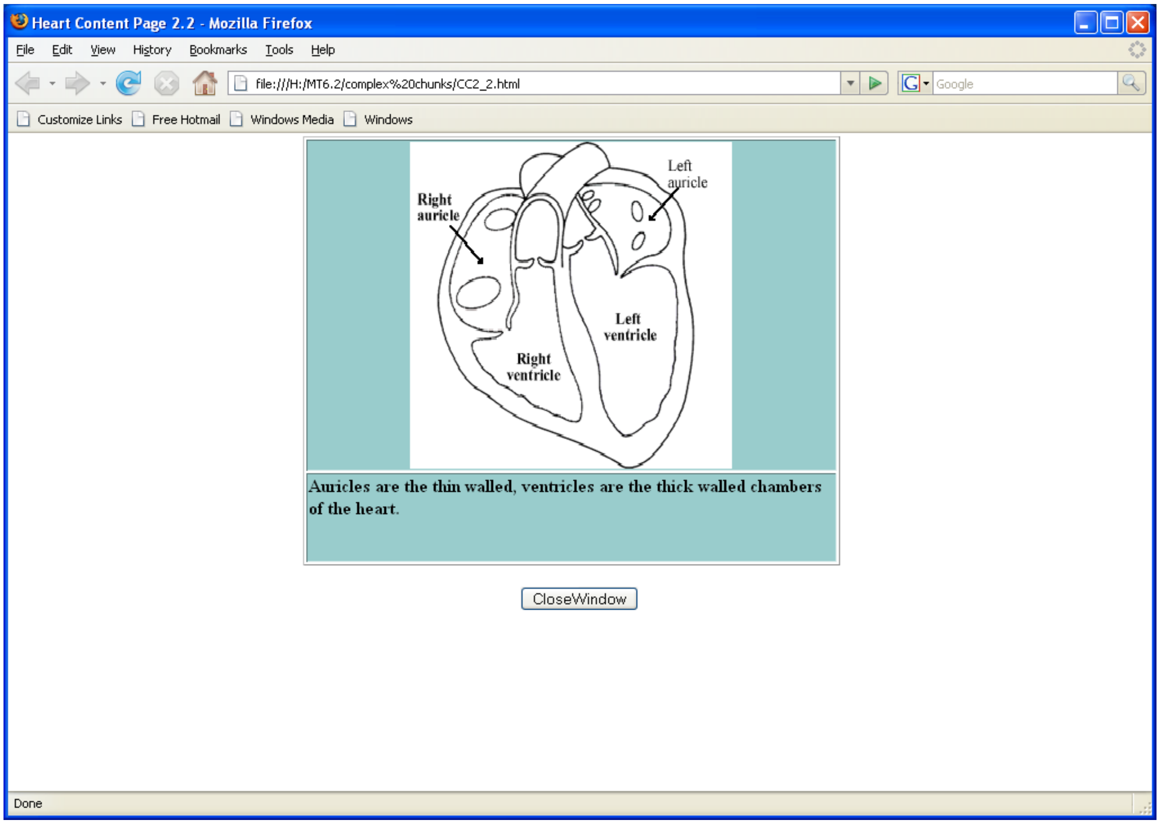

Heart Content Page 6.8 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC6_8.html
Google
Customize Links Free Hotmail Windows Media Windows
Heart Content Page 6.10
Heart Content Page 6.8
Aorta
Mitral valve
Aortic Valve
Mitral valve is beginning to open, when the blood in the aorta is exerting a superior pressure on the aortic valve
CloseWindow
Done

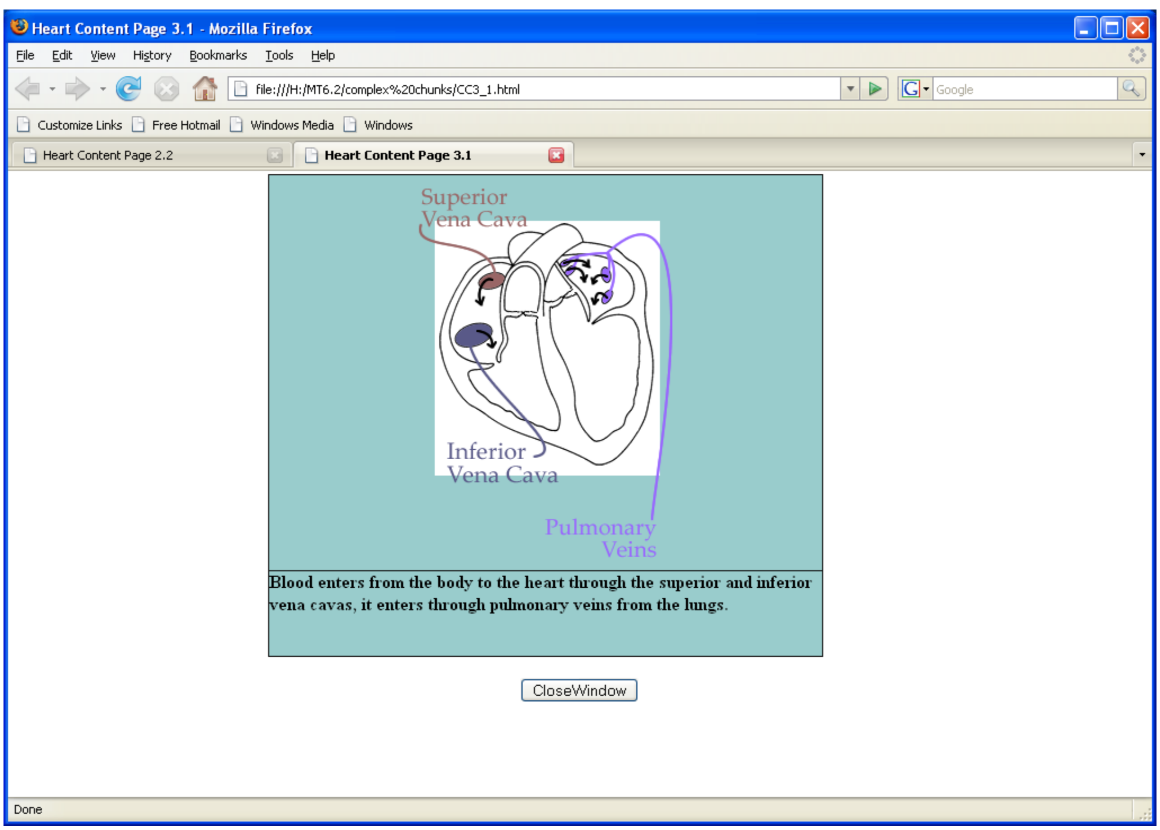

Heart Content Page 6.10 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Simplechunks/SC6_9.html
Google
Customize Links Free Hotmail Windows Media Windows
Diastolic:
Lowest Pressure
The ventricles are partially full of blood and relaxing in the diastolic phase.
CloseWindow
Done



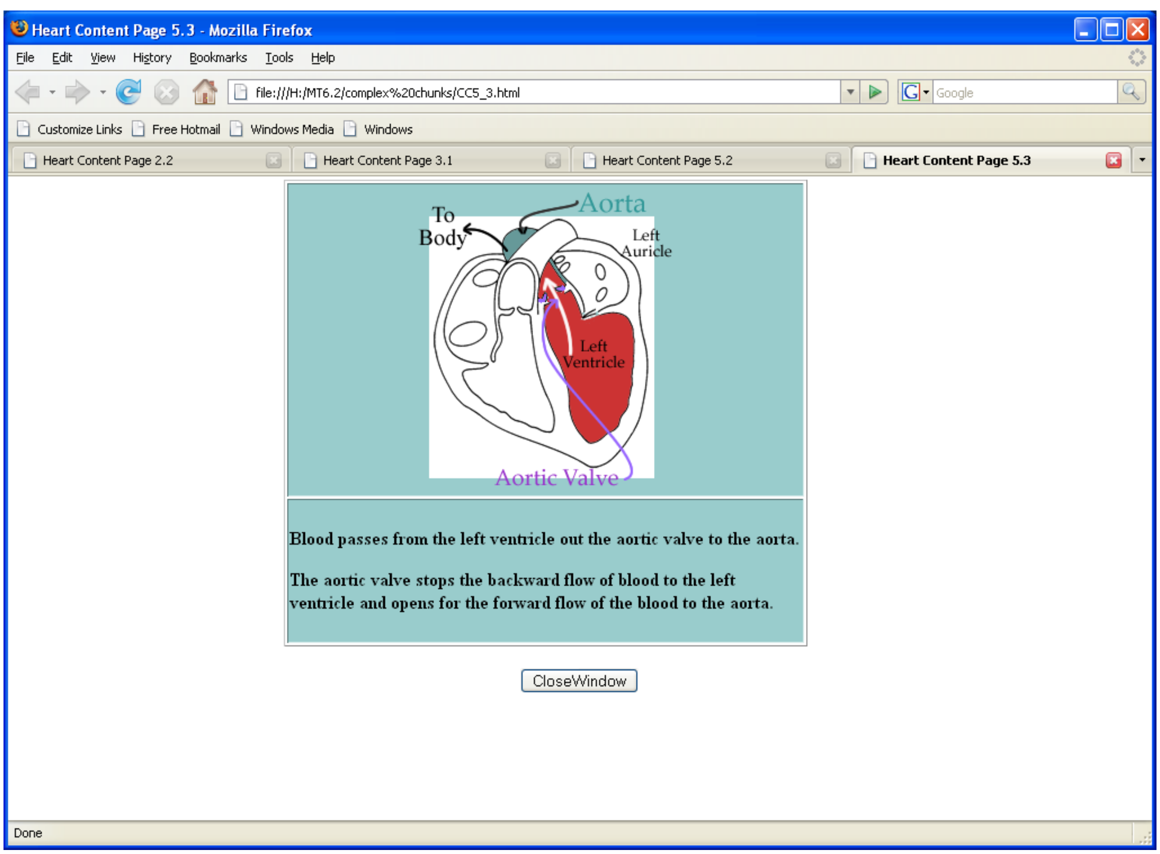
Group 2 Complex visual/text chunking




Heart Content Page 2.2 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC2_2.html
Customize Links Free Hotmail Windows Media Windows
Left auricle
Right auricle
Left ventricle
Right ventricle
Auricles are the thin walled, ventricles are the thick walled chambers of the heart.
CloseWindow
Done


Heart Content Page 3.1 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC3_1.html
Customize Links Free Hotmail Windows Media Windows
Heart Content Page 2.2
Heart Content Page 3.1
Superior Vena Cava
Inferior Vena Cava
Pulmonary Veins
Blood enters from the body to the heart through the superior and inferior vena cavas, it enters through pulmonary veins from the lungs.
CloseWindow
Done


Heart Content Page 5.2 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC5_2.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Heart Content Page 2.2
Heart Content Page 3.1
Heart Content Page 5.2
Auricles
Right
Left
Ventricles
The left ventricle is the largest, strongest, and most muscular section of the heart.
Left ventricle is the chamber of the heart which pumps oxygenated blood to all parts of the body while auricles act as receiving rooms for the blood.
CloseWindow
Done


Heart Content Page 5.3 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
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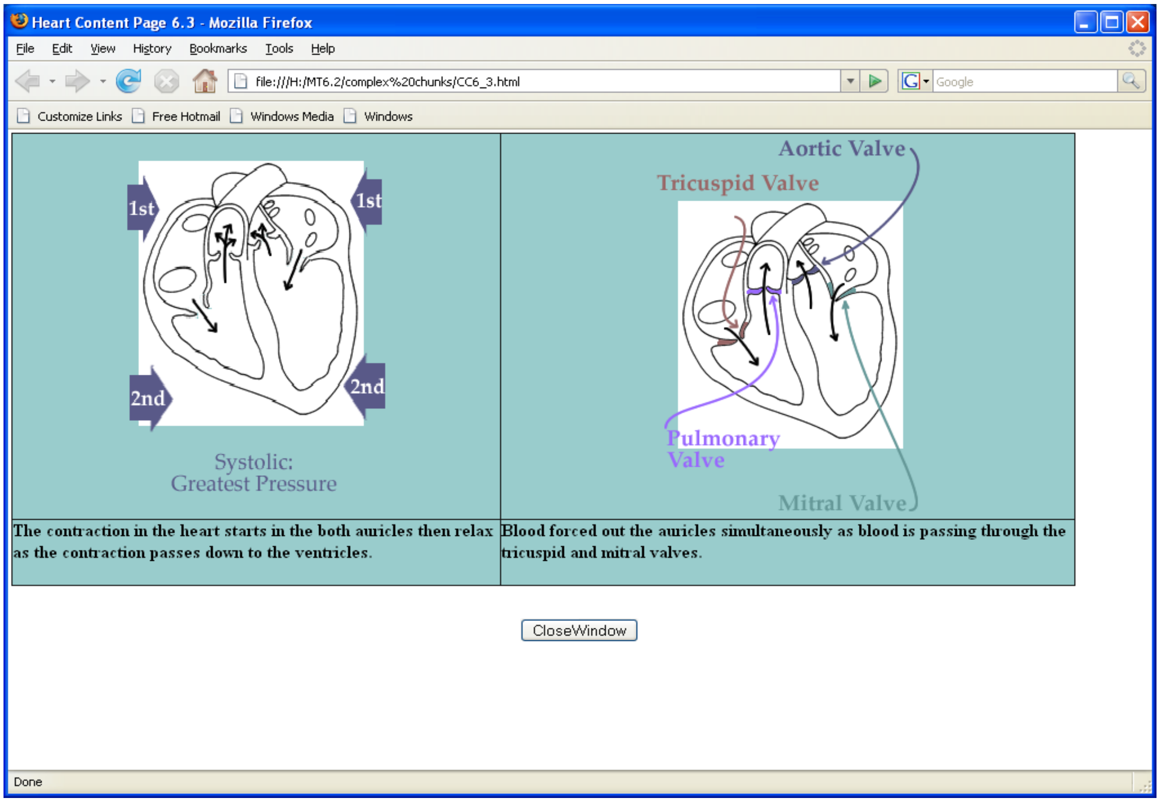
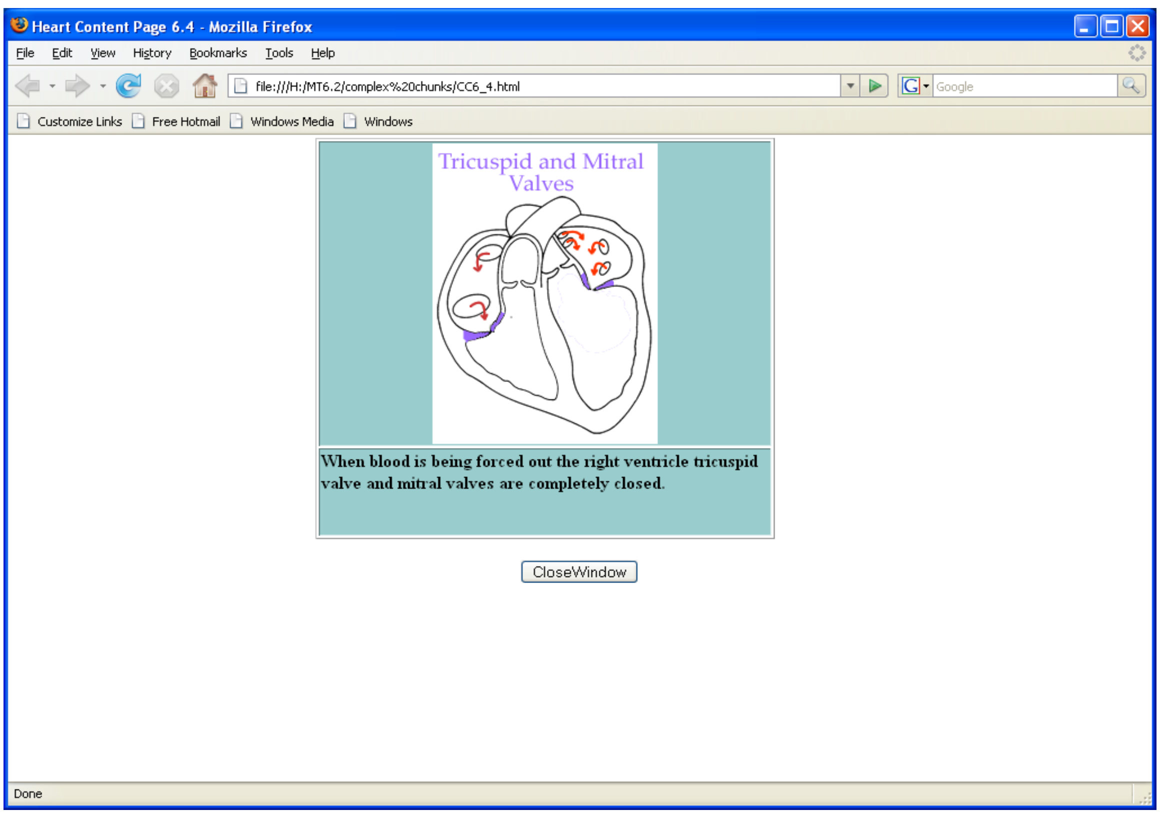
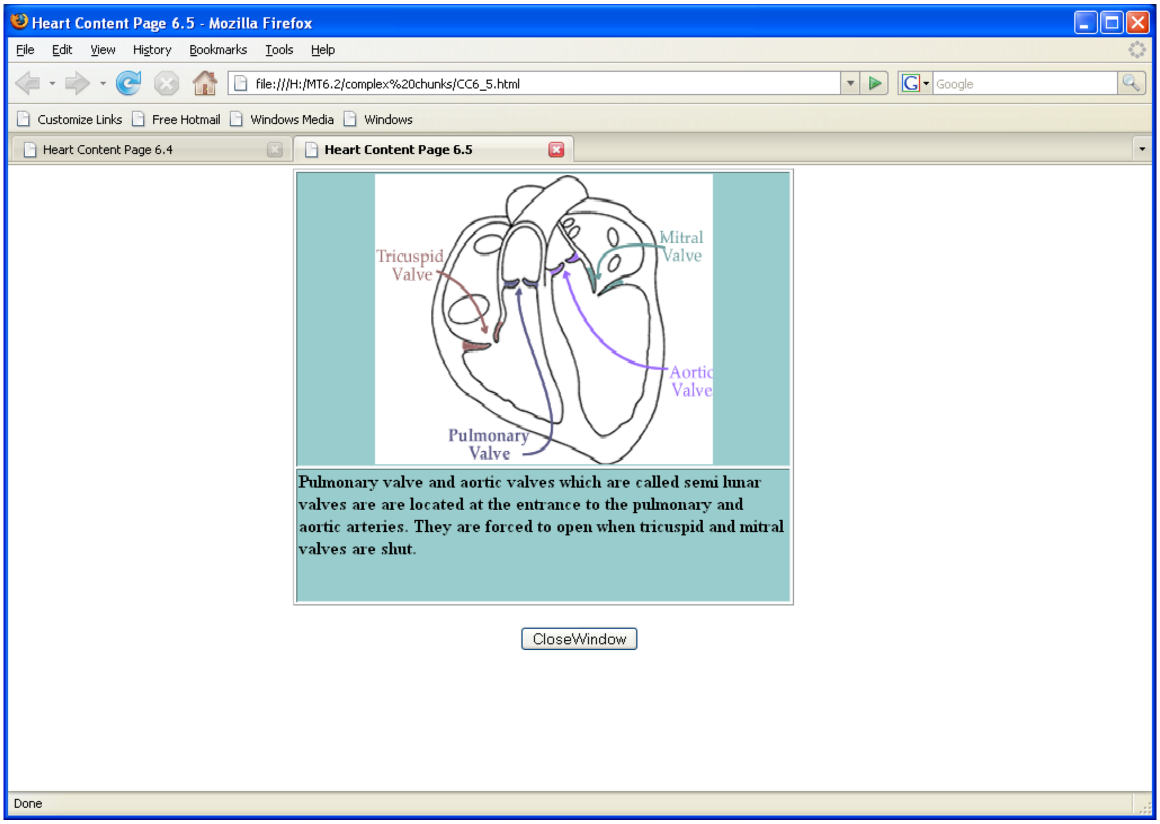
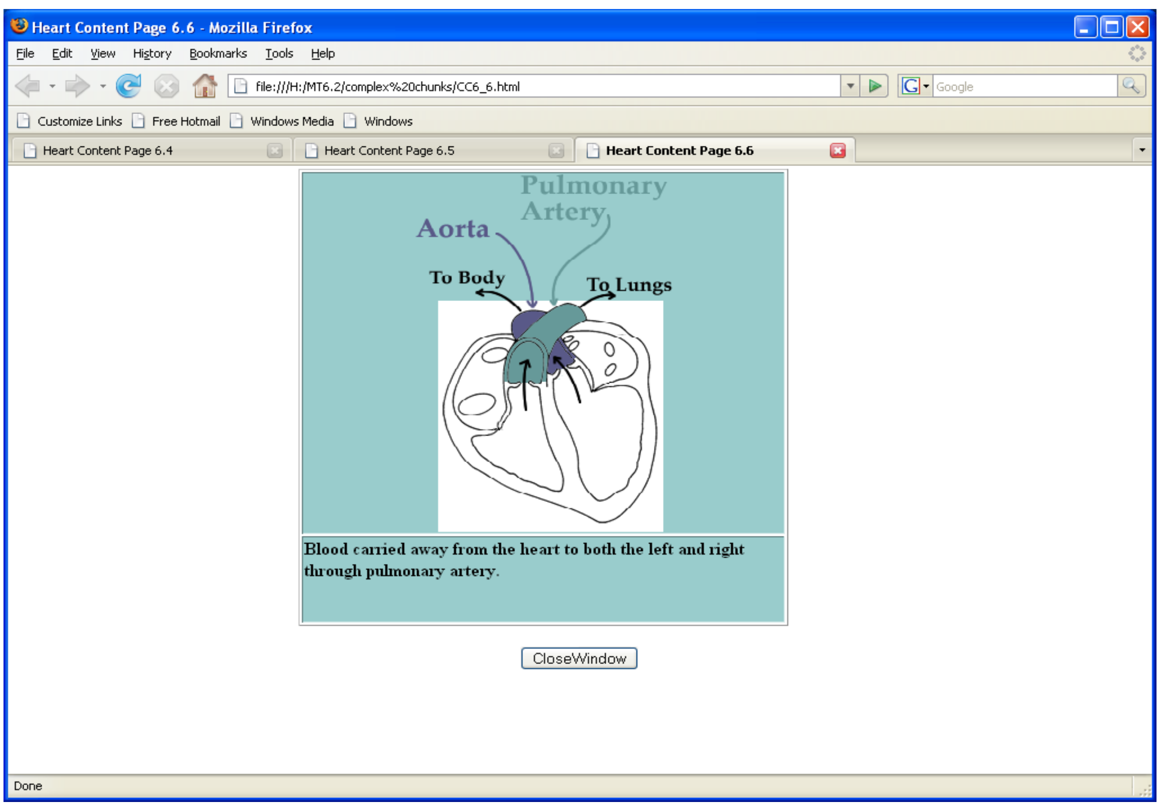
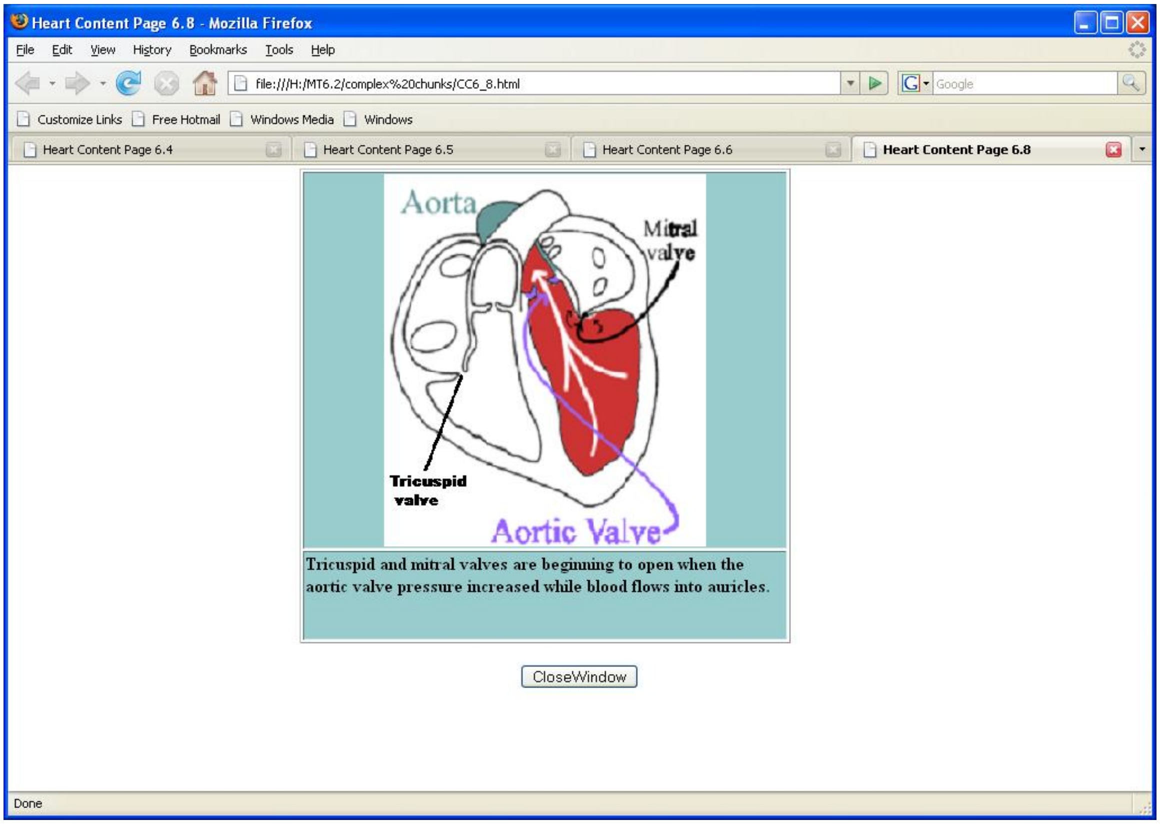
Google
Customize Links
Free Hotmail
Windows Media
Windows
Heart Content Page 2.2
Heart Content Page 3.1
Heart Content Page 5.2
Heart Content Page 5.3
Aorta
To Body
Left Auricle
Left Ventricle
Aortic Valve
Blood passes from the left ventricle out the aortic valve to the aorta.
The aortic valve stops the backward flow of blood to the left ventricle and opens for the forward flow of the blood to the aorta.
CloseWindow
Done

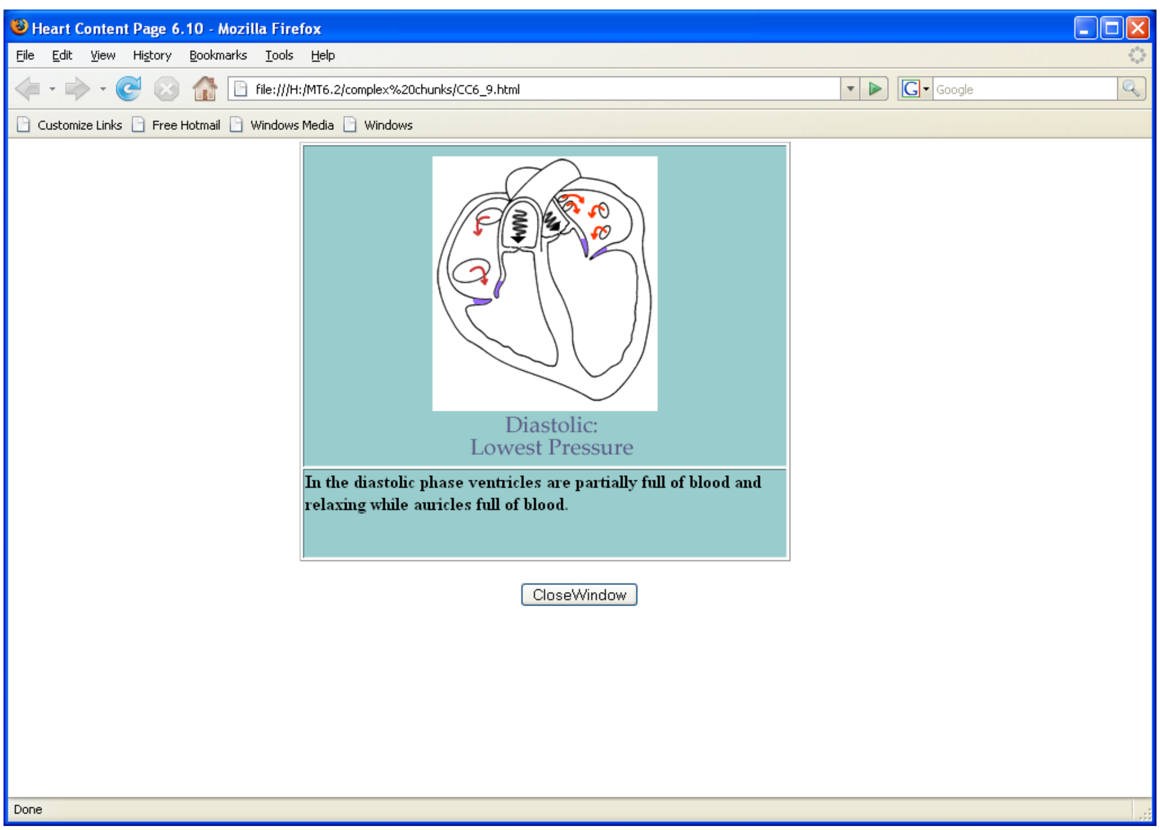

Heart Content Page 6.3 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC6_3.html
Customize Links Free Hotmail Windows Media Windows
1st
1st
2nd
2nd
Systolic:
Greatest Pressure
Aortic Valve
Tricuspid Valve
Pulmonary Valve
Mitral Valve
The contraction in the heart starts in the both auricles then relax as the contraction passes down to the ventricles.
Blood forced out the auricles simultaneously as blood is passing through the tricuspid and mitral valves.
CloseWindow
Done

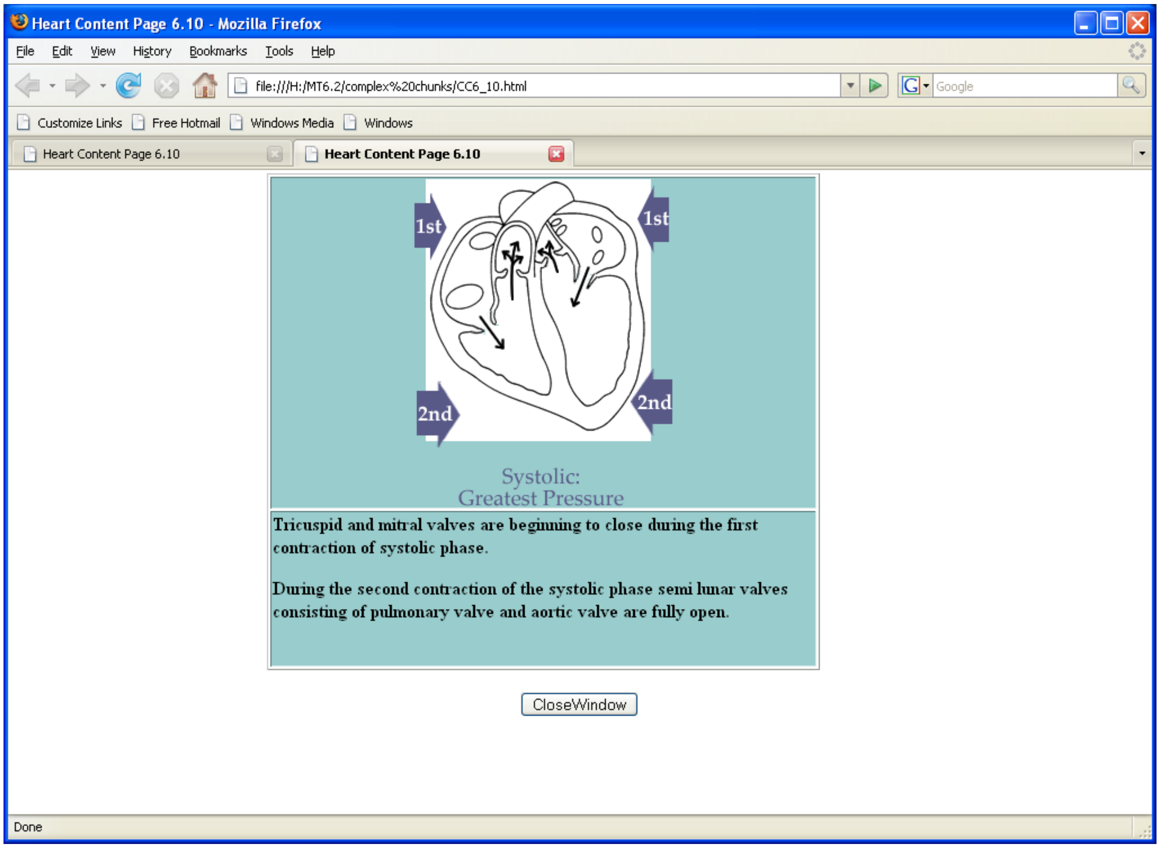

Heart Content Page 6.4 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC6_4.html
Customize Links Free Hotmail Windows Media Windows
Tricuspid and Mitral Valves
When blood is being forced out the right ventricle tricuspid valve and mitral valves are completely closed.
CloseWindow
Done


Heart Content Page 6.5 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC6_5.html
Google
Customize Links Free Hotmail Windows Media Windows
Heart Content Page 6.4
Heart Content Page 6.5
Tricuspid Valve
Mitral Valve
Aortic Valve
Pulmonary Valve
Pulmonary valve and aortic valves which are called semi lunar valves are are located at the entrance to the pulmonary and aortic arteries. They are forced to open when tricuspid and mitral valves are shut.
CloseWindow
Done


Heart Content Page 6.6 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC6_6.html
Google
Customize Links Free Hotmail Windows Media Windows
Heart Content Page 6.4
Heart Content Page 6.5
Heart Content Page 6.6
Pulmonary Artery
Aorta
To Body
To Lungs
Blood carried away from the heart to both the left and right through pulmonary artery.
CloseWindow
Done


Heart Content Page 6.8 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC6_8.html
Customize Links Free Hotmail Windows Media Windows
Heart Content Page 6.4 Heart Content Page 6.5 Heart Content Page 6.6 Heart Content Page 6.8
Aorta
Mitral valve
Tricuspid valve
Aortic Valve
Tricuspid and mitral valves are beginning to open when the aortic valve pressure increased while blood flows into auricles.
CloseWindow
Done

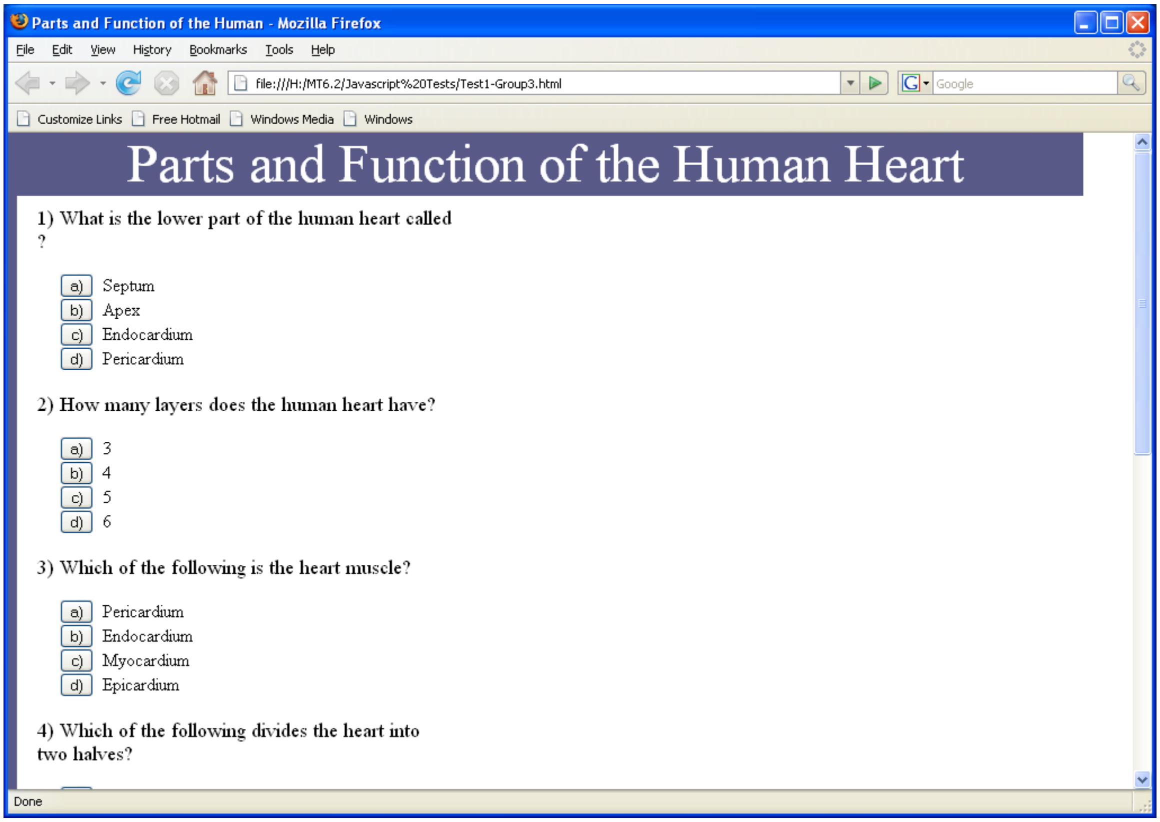

Heart Content Page 6.10 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC6_9.html
Customize Links Free Hotmail Windows Media Windows
Diastolic:
Lowest Pressure
In the diastolic phase ventricles are partially full of blood and relaxing while auricles full of blood.
CloseWindow
Done

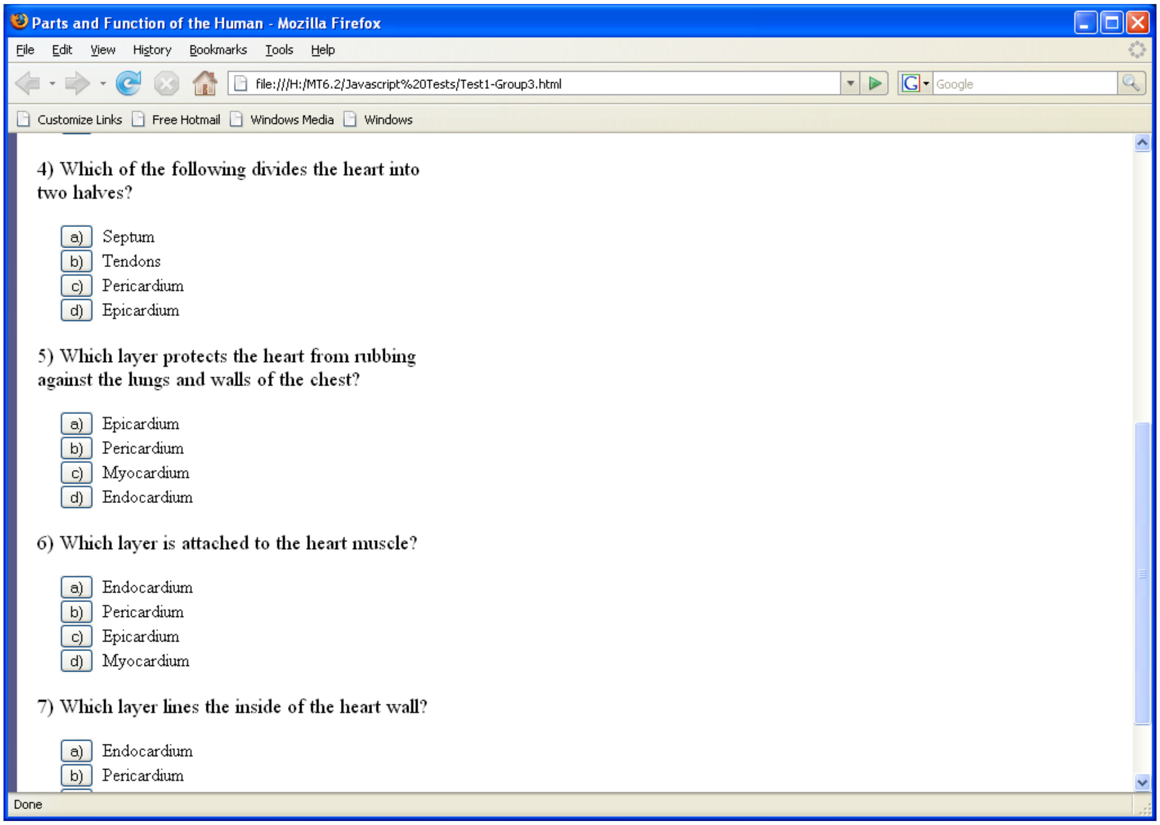

Heart Content Page 6.10 - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/complex%20chunks/CC6_10.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Heart Content Page 6.10
Heart Content Page 6.10
1st
1st
2nd
2nd
Systolic:
Greatest Pressure
Tricuspid and mitral valves are beginning to close during the first contraction of systolic phase.
During the second contraction of the systolic phase semi lunar valves consisting of pulmonary valve and aortic valve are fully open.
CloseWindow
Done

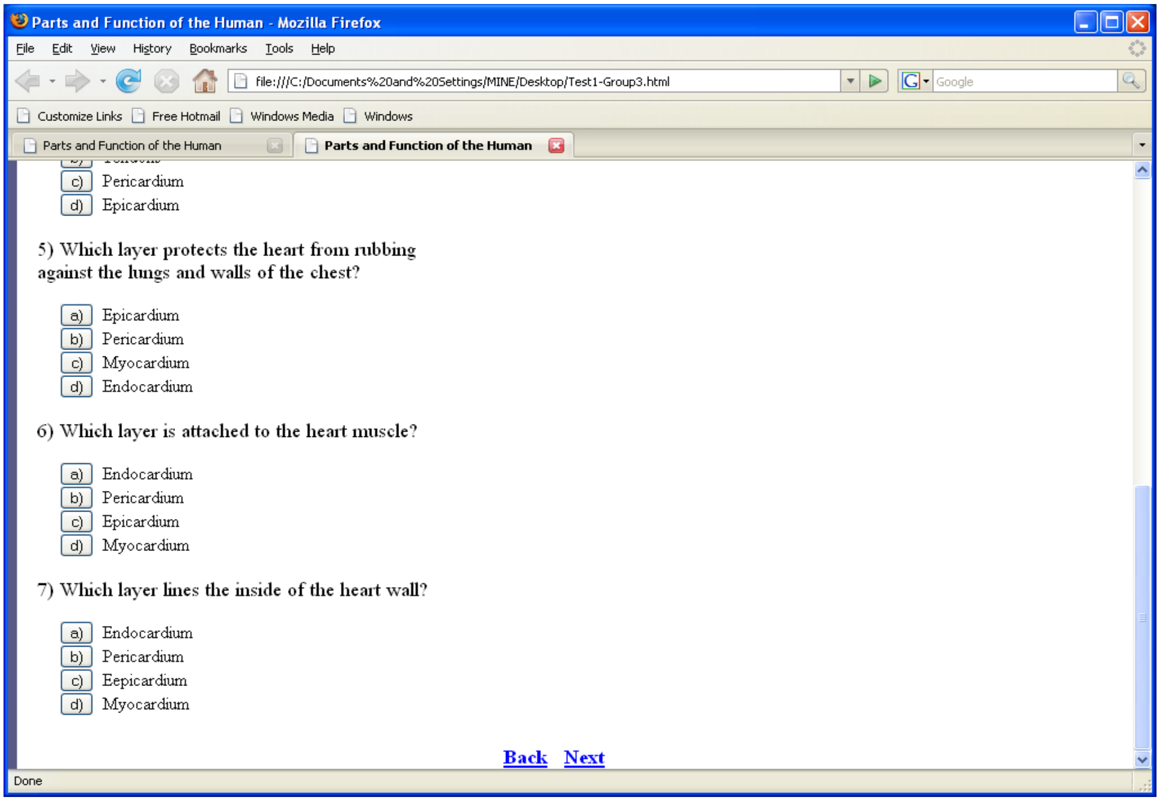
Appendix C

Feedback Frames

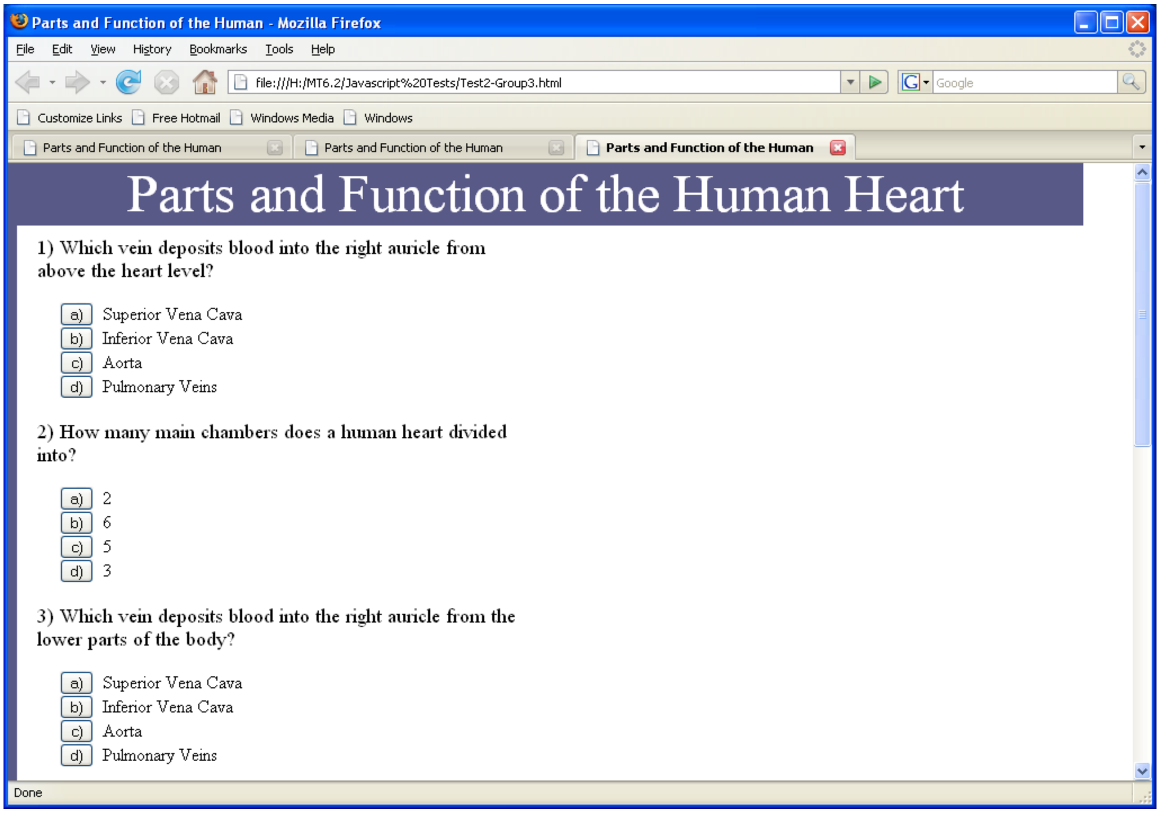
Frame-1

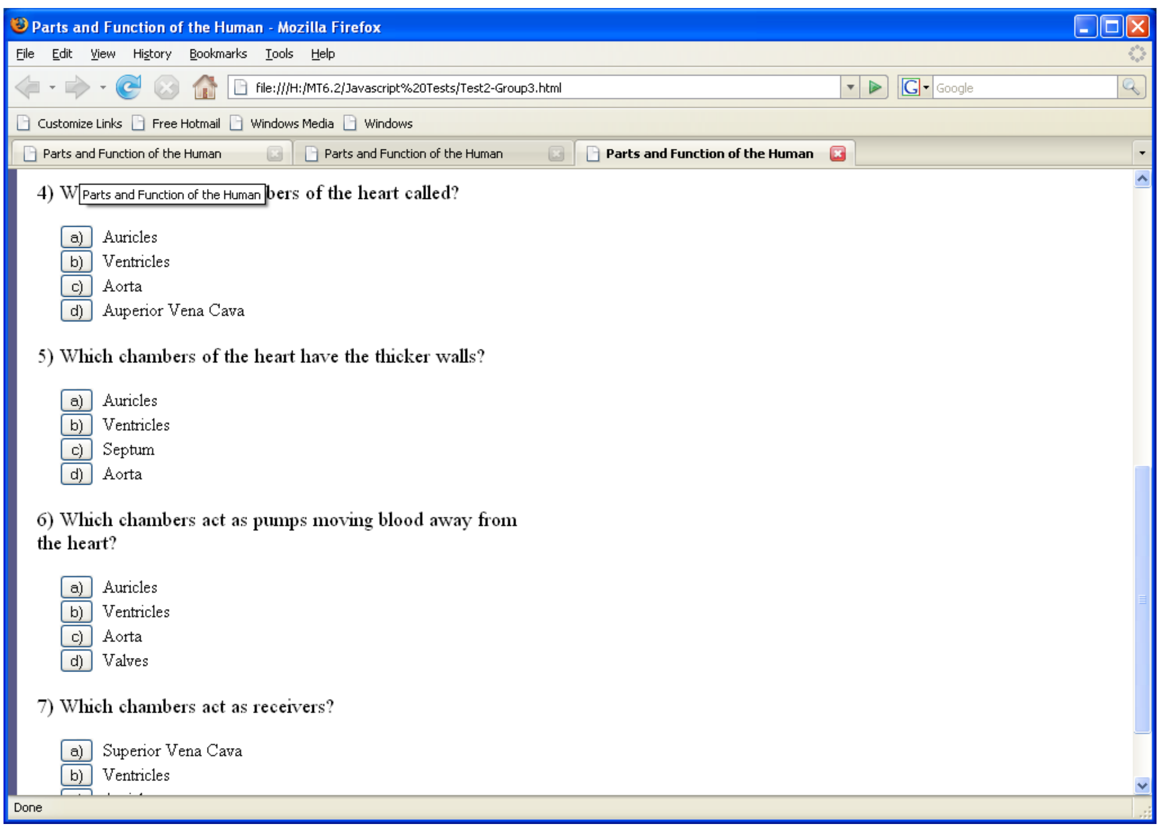


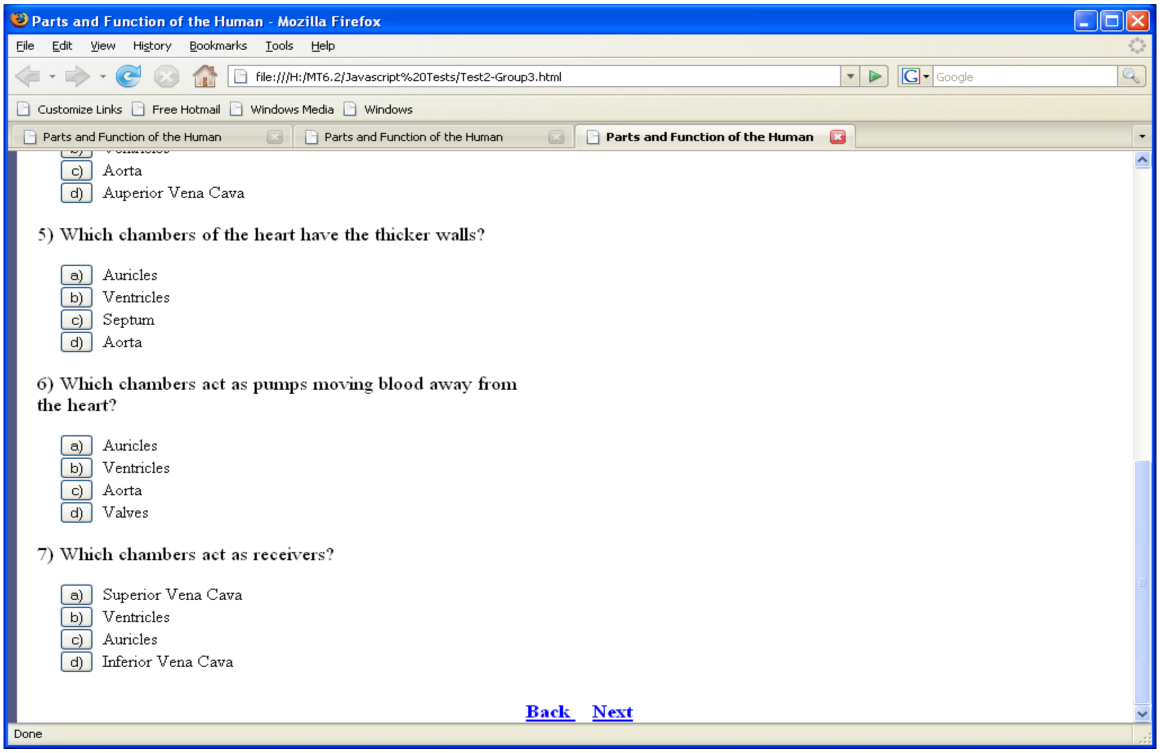

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test1-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
4) Which of the following divides the heart into two halves?
a) Septum
b) Tendons
c) Pericardium
d) Epicardium
5) Which layer protects the heart from rubbing against the lungs and walls of the chest?
a) Epicardium
b) Pericardium
c) Myocardium
d) Endocardium
6) Which layer is attached to the heart muscle?
a) Endocardium
b) Pericardium
c) Epicardium
d) Myocardium
7) Which layer lines the inside of the heart wall?
a) Endocardium
b) Pericardium
Done


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///C:/Documents%20and%20Settings/MINE/Desktop/Test1-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
Parts and Function of the Human
Parts and Function of the Human
c) Pericardium
d) Epicardium
5) Which layer protects the heart from rubbing against the lungs and walls of the chest?
a) Epicardium
b) Pericardium
c) Myocardium
d) Endocardium
6) Which layer is attached to the heart muscle?
a) Endocardium
b) Pericardium
c) Epicardium
d) Myocardium
7) Which layer lines the inside of the heart wall?
a) Endocardium
b) Pericardium
c) Eepicardium
d) Myocardium
Back Next
Done

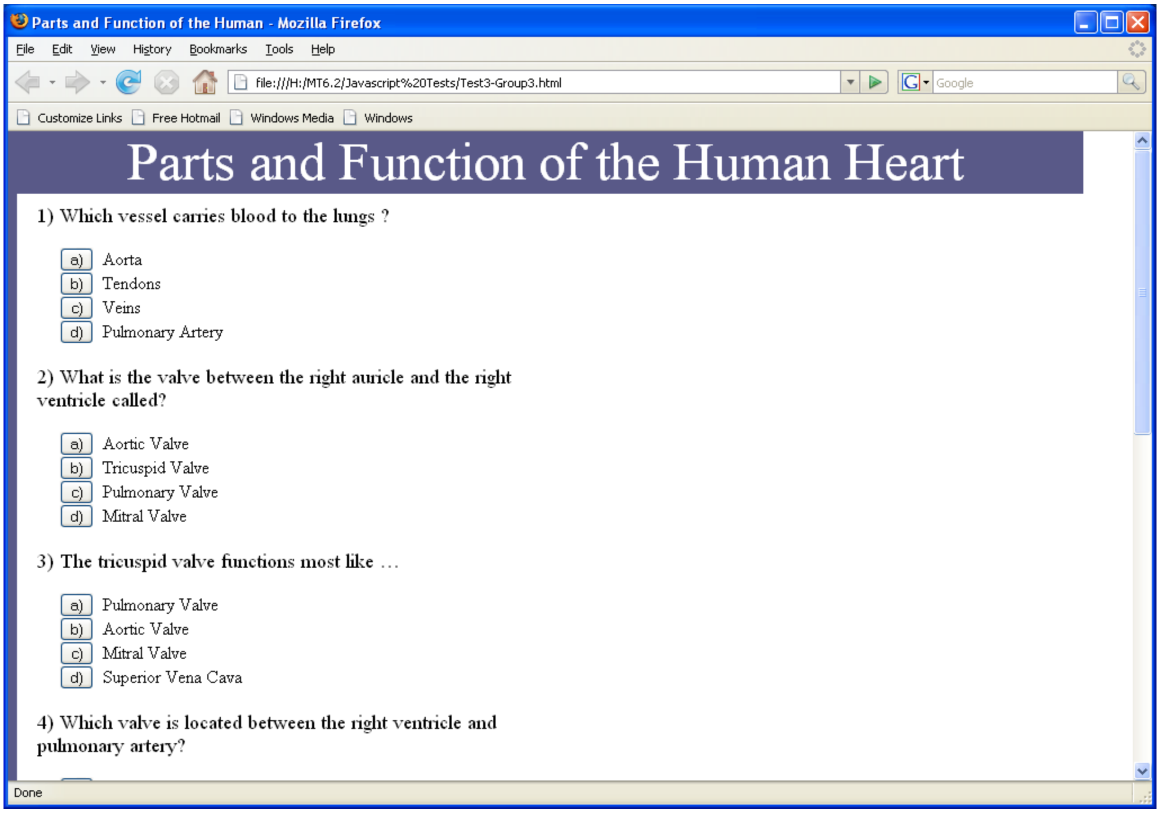
Frame 2

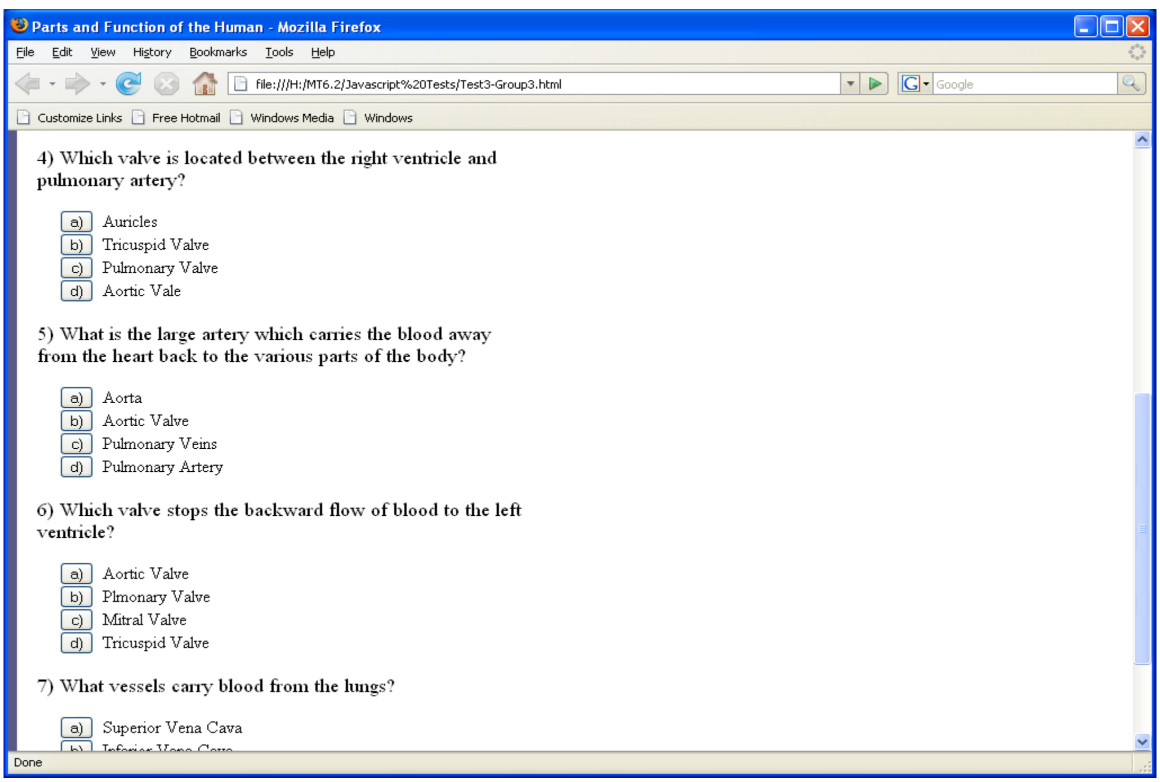

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test2-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
Parts and Function of the Human
Parts and Function of the Human
Parts and Function of the Human
Parts and Function of the Human Heart
1) Which vein deposits blood into the right auricle from above the heart level?
a) Superior Vena Cava
b) Inferior Vena Cava
c) Aorta
d) Pulmonary Veins
2) How many main chambers does a human heart divided into?
a) 2
b) 6
c) 5
d) 3
3) Which vein deposits blood into the right auricle from the lower parts of the body?
a) Superior Vena Cava
b) Inferior Vena Cava
c) Aorta
d) Pulmonary Veins
Done

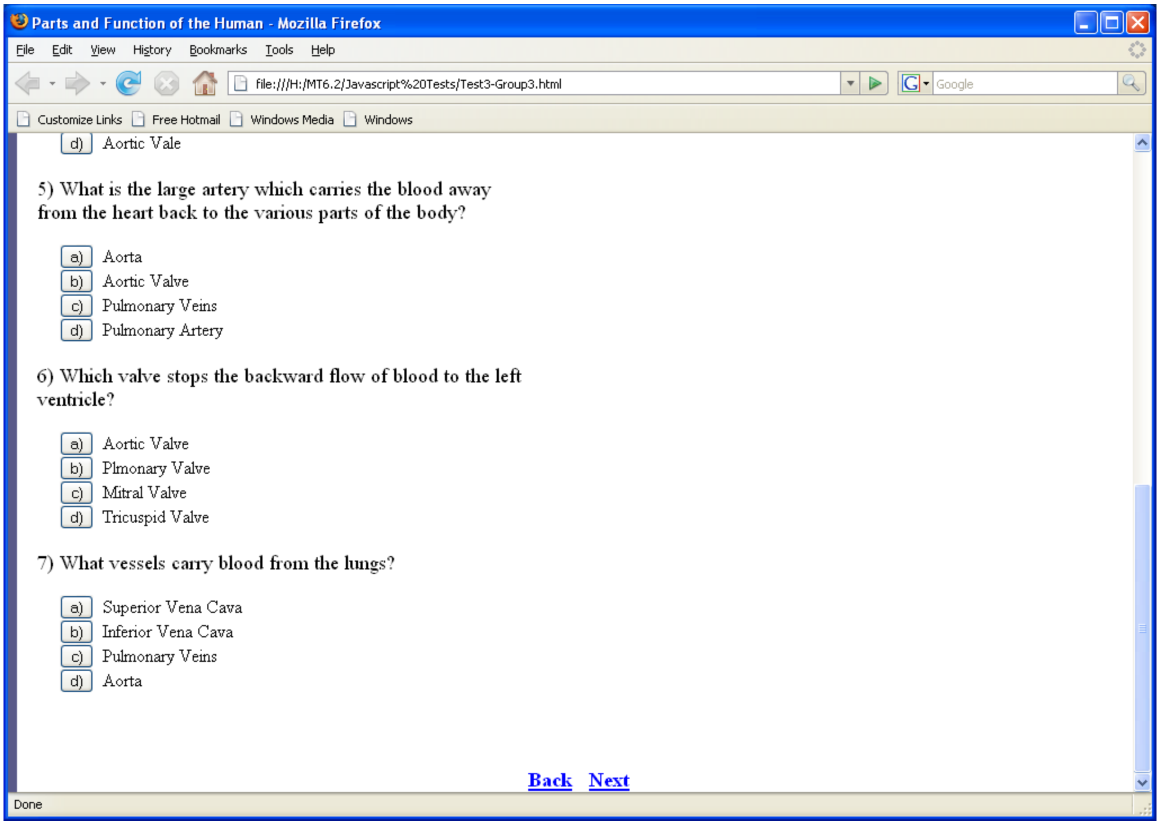

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test2-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
Parts and Function of the Human
Parts and Function of the Human
Parts and Function of the Human
4) W Parts and Function of the Human bers of the heart called?
a) Auricles
b) Ventricles
c) Aorta
d) Auperior Vena Cava
5) Which chambers of the heart have the thicker walls?
a) Auricles
b) Ventricles
c) Septum
d) Aorta
6) Which chambers act as pumps moving blood away from the heart?
a) Auricles
b) Ventricles
c) Aorta
d) Valves
7) Which chambers act as receivers?
a) Superior Vena Cava
b) Ventricles
Done


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test2-Group3.html
Customize Links
Free Hotmail
Windows Media
Windows
Parts and Function of the Human
Parts and Function of the Human
Parts and Function of the Human
c) Aorta
d) Auperior Vena Cava
5) Which chambers of the heart have the thicker walls?
a) Auricles
b) Ventricles
c) Septum
d) Aorta
6) Which chambers act as pumps moving blood away from the heart?
a) Auricles
b) Ventricles
c) Aorta
d) Valves
7) Which chambers act as receivers?
a) Superior Vena Cava
b) Ventricles
c) Auricles
d) Inferior Vena Cava
Back Next
Done

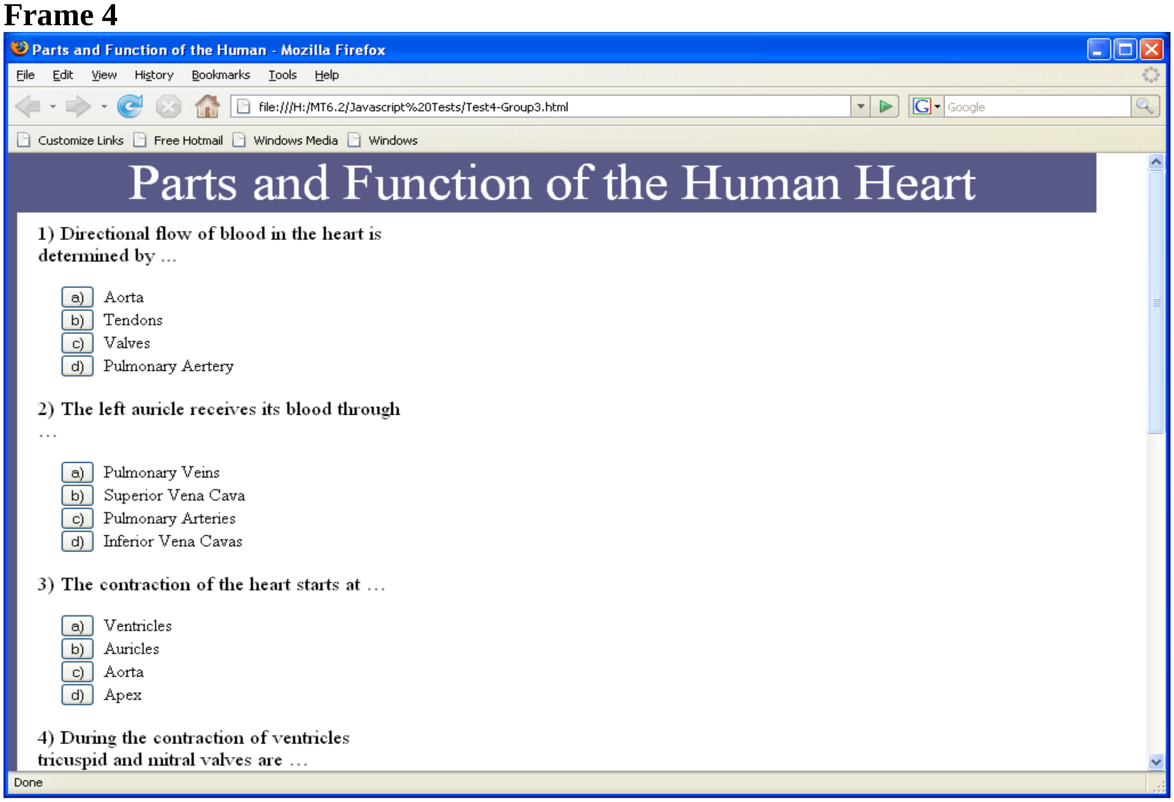
Frame 3

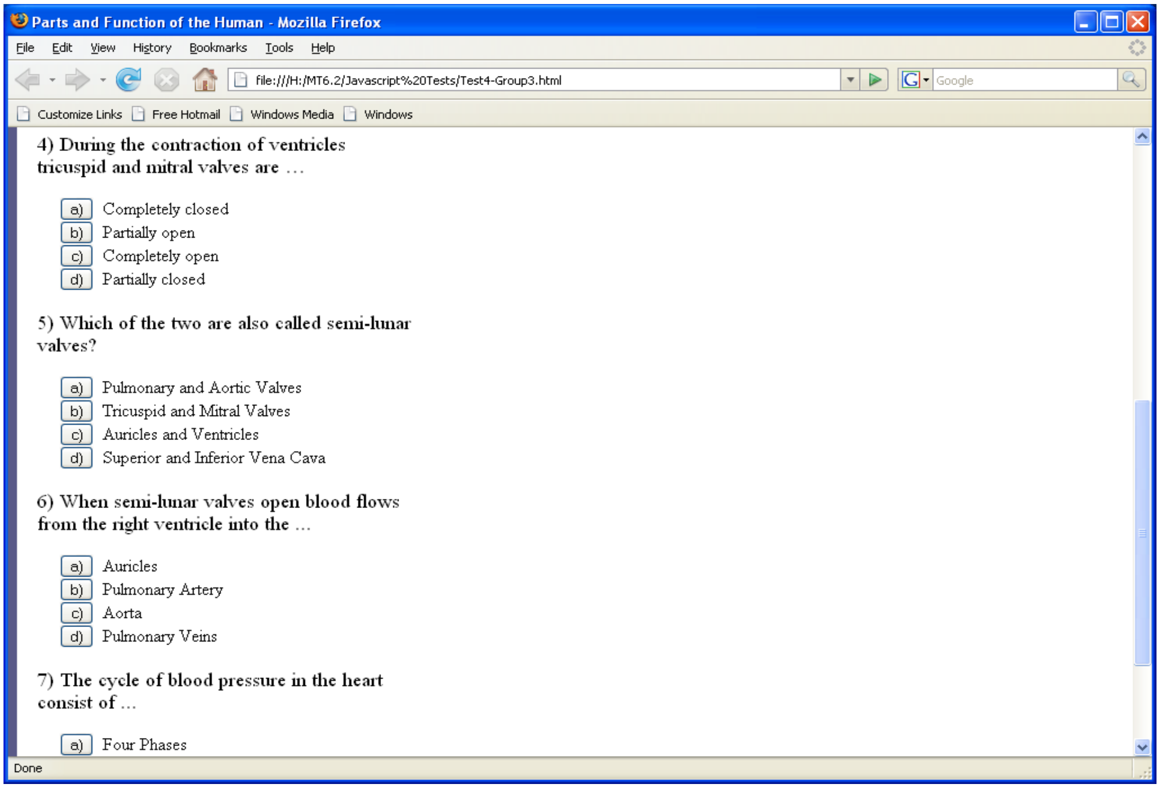

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test3-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
Parts and Function of the Human Heart
1) Which vessel carries blood to the lungs ?
a) Aorta
b) Tendons
c) Veins
d) Pulmonary Artery
2) What is the valve between the right auricle and the right ventricle called?
a) Aortic Valve
b) Tricuspid Valve
c) Pulmonary Valve
d) Mitral Valve
3) The tricuspid valve functions most like …
a) Pulmonary Valve
b) Aortic Valve
c) Mitral Valve
d) Superior Vena Cava
4) Which valve is located between the right ventricle and pulmonary artery?
Done

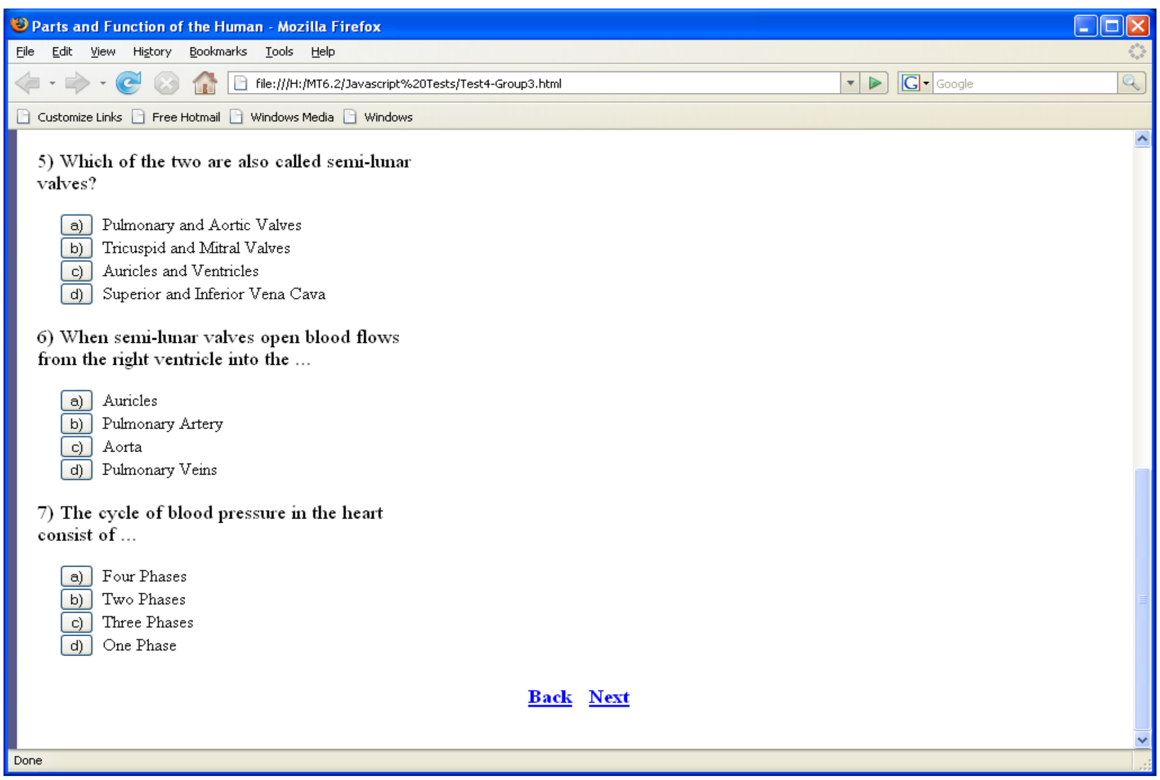

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test3-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
4) Which valve is located between the right ventricle and pulmonary artery?
a) Auricles
b) Tricuspid Valve
c) Pulmonary Valve
d) Aortic Vale
5) What is the large artery which carries the blood away from the heart back to the various parts of the body?
a) Aorta
b) Aortic Valve
c) Pulmonary Veins
d) Pulmonary Artery
6) Which valve stops the backward flow of blood to the left ventricle?
a) Aortic Valve
b) Plmonary Valve
c) Mitral Valve
d) Tricuspid Valve
7) What vessels carry blood from the lungs?
a) Superior Vena Cava
Done


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test3-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
d) Aortic Vale
5) What is the large artery which carries the blood away from the heart back to the various parts of the body?
a) Aorta
b) Aortic Valve
c) Pulmonary Veins
d) Pulmonary Artery
6) Which valve stops the backward flow of blood to the left ventricle?
a) Aortic Valve
b) Plmonary Valve
c) Mitral Valve
d) Tricuspid Valve
7) What vessels carry blood from the lungs?
a) Superior Vena Cava
b) Inferior Vena Cava
c) Pulmonary Veins
d) Aorta
Back Next
Done

Frame 4

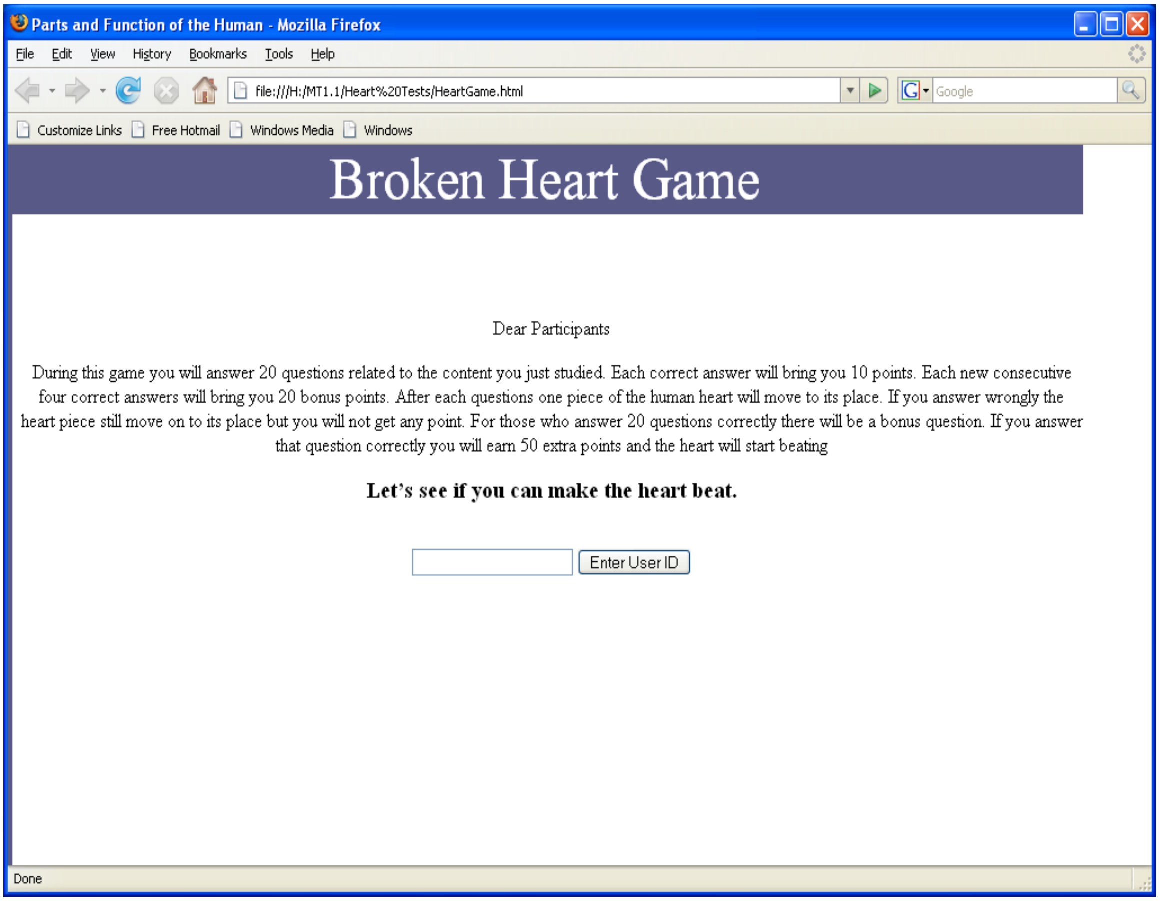

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test4-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
Parts and Function of the Human Heart
1) Directional flow of blood in the heart is determined by ...
a) Aorta
b) Tendons
c) Valves
d) Pulmonary Aertery
2) The left auricle receives its blood through ...
a) Pulmonary Veins
b) Superior Vena Cava
c) Pulmonary Arteries
d) Inferior Vena Cavas
3) The contraction of the heart starts at ...
a) Ventricles
b) Auricles
c) Aorta
d) Apex
4) During the contraction of ventricles tricuspid and mitral valves are ...
Done

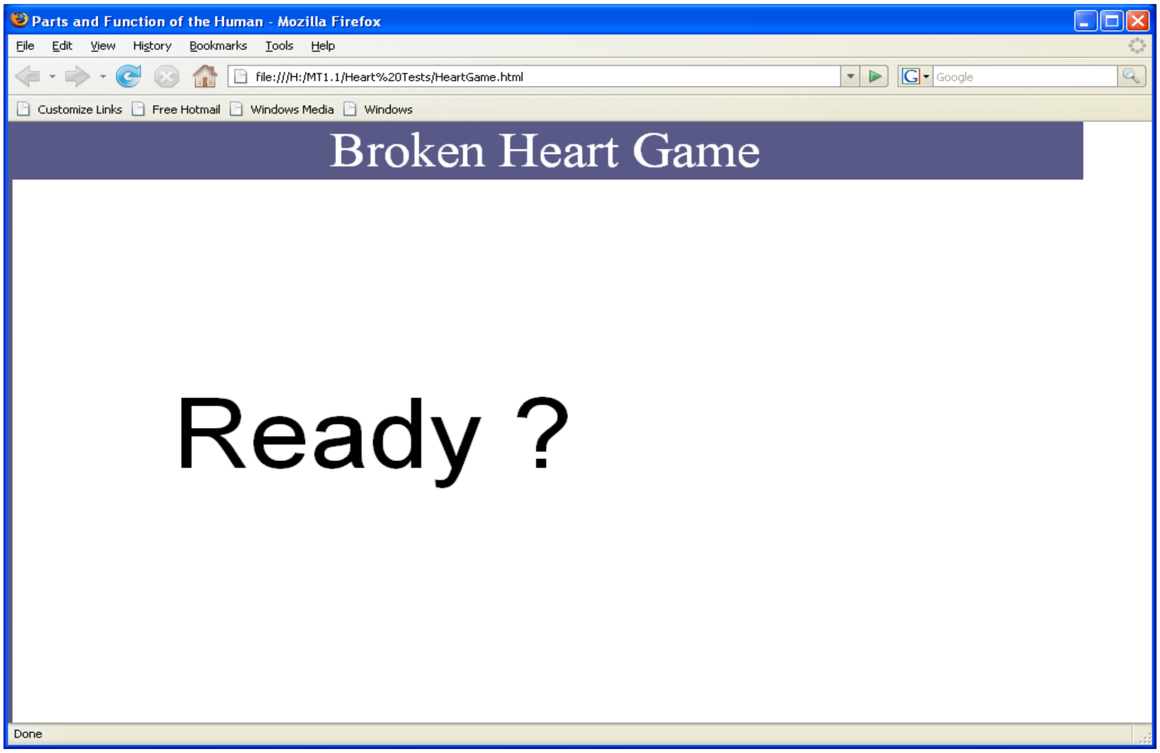

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test4-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
4) During the contraction of ventricles tricuspid and mitral valves are …
a) Completely closed
b) Partially open
c) Completely open
d) Partially closed
5) Which of the two are also called semi-lunar valves?
a) Pulmonary and Aortic Valves
b) Tricuspid and Mitral Valves
c) Auricles and Ventricles
d) Superior and Inferior Vena Cava
6) When semi-lunar valves open blood flows from the right ventricle into the …
a) Auricles
b) Pulmonary Artery
c) Aorta
d) Pulmonary Veins
7) The cycle of blood pressure in the heart consist of …
a) Four Phases
Done

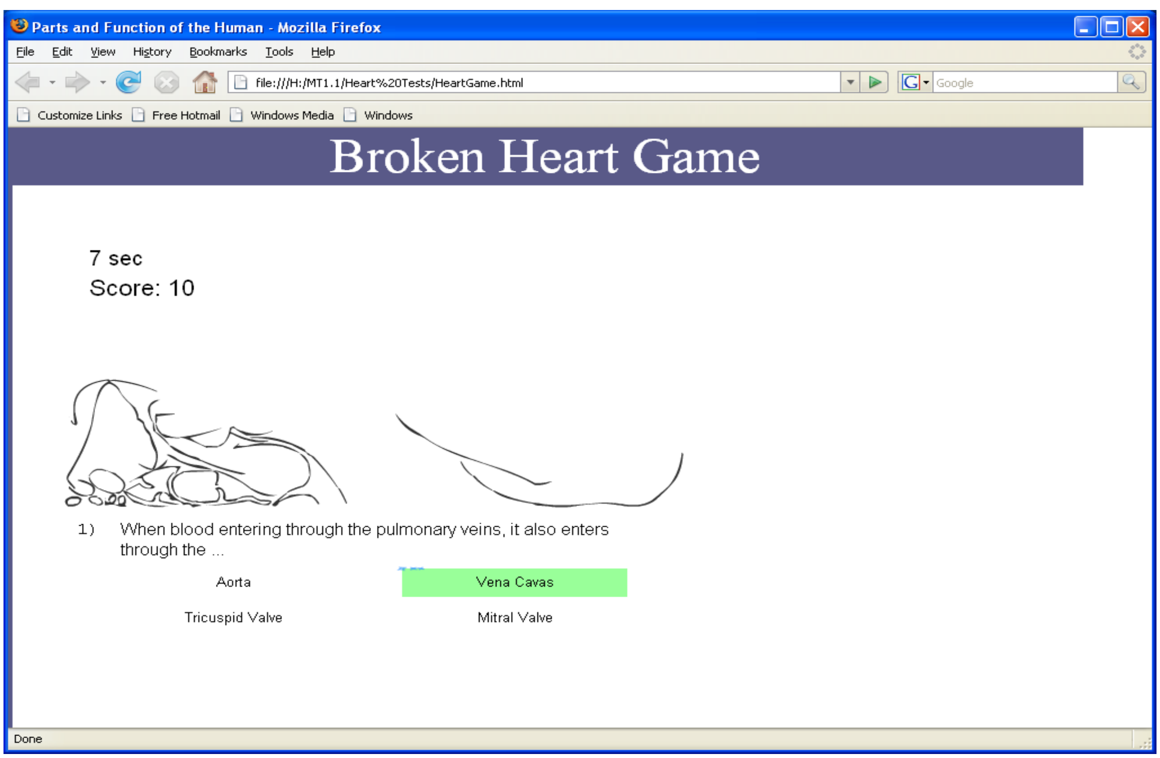

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT6.2/Javascript%20Tests/Test4-Group3.html
Google
Customize Links Free Hotmail Windows Media Windows
5) Which of the two are also called semi-lunar valves?
a) Pulmonary and Aortic Valves
b) Tricuspid and Mitral Valves
c) Auricles and Ventricles
d) Superior and Inferior Vena Cava
6) When semi-lunar valves open blood flows from the right ventricle into the …
a) Auricles
b) Pulmonary Artery
c) Aorta
d) Pulmonary Veins
7) The cycle of blood pressure in the heart consist of …
a) Four Phases
b) Two Phases
c) Three Phases
d) One Phase
Back Next
Done

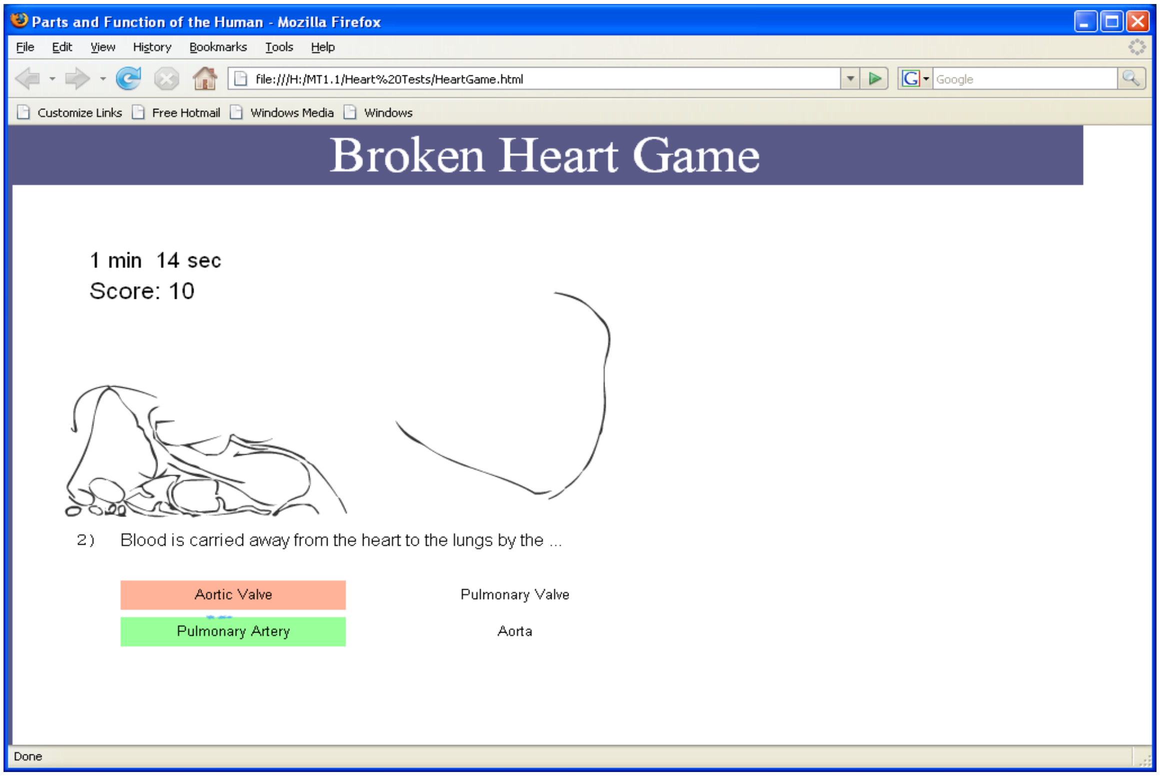
Appendix D

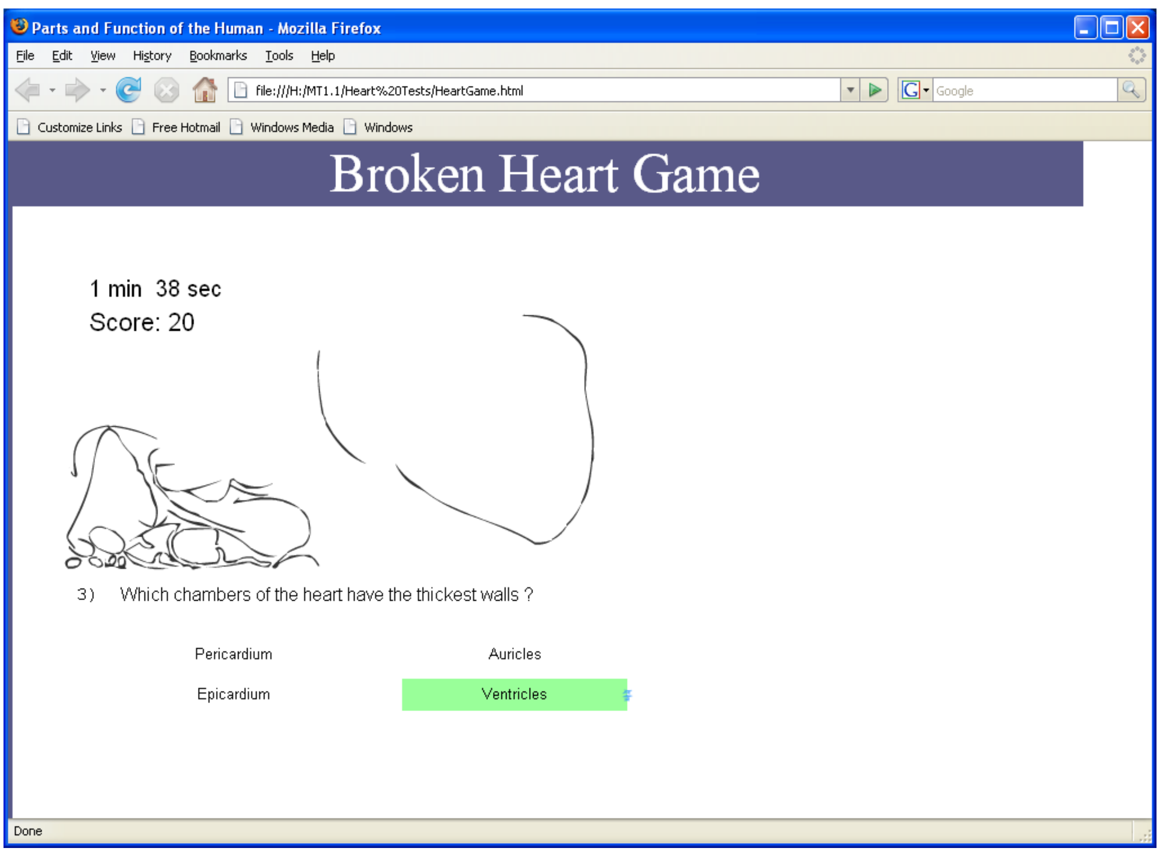
Broken Heart Game Frames

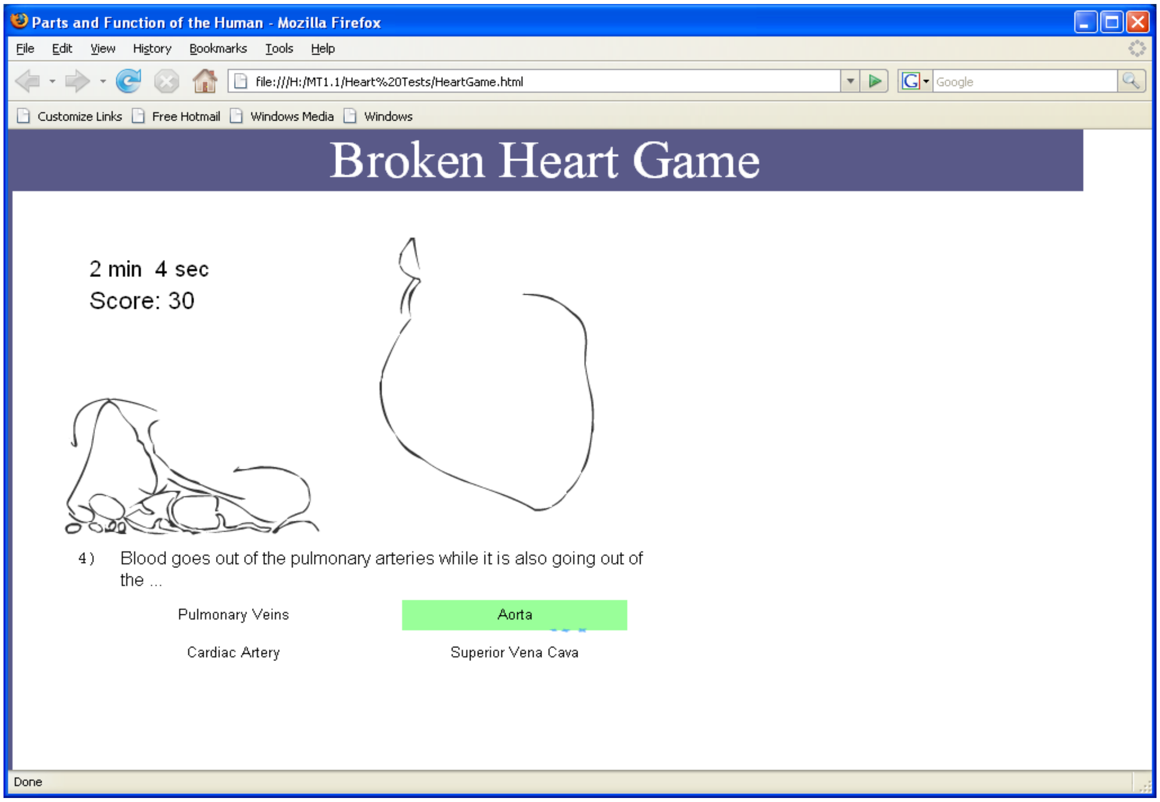


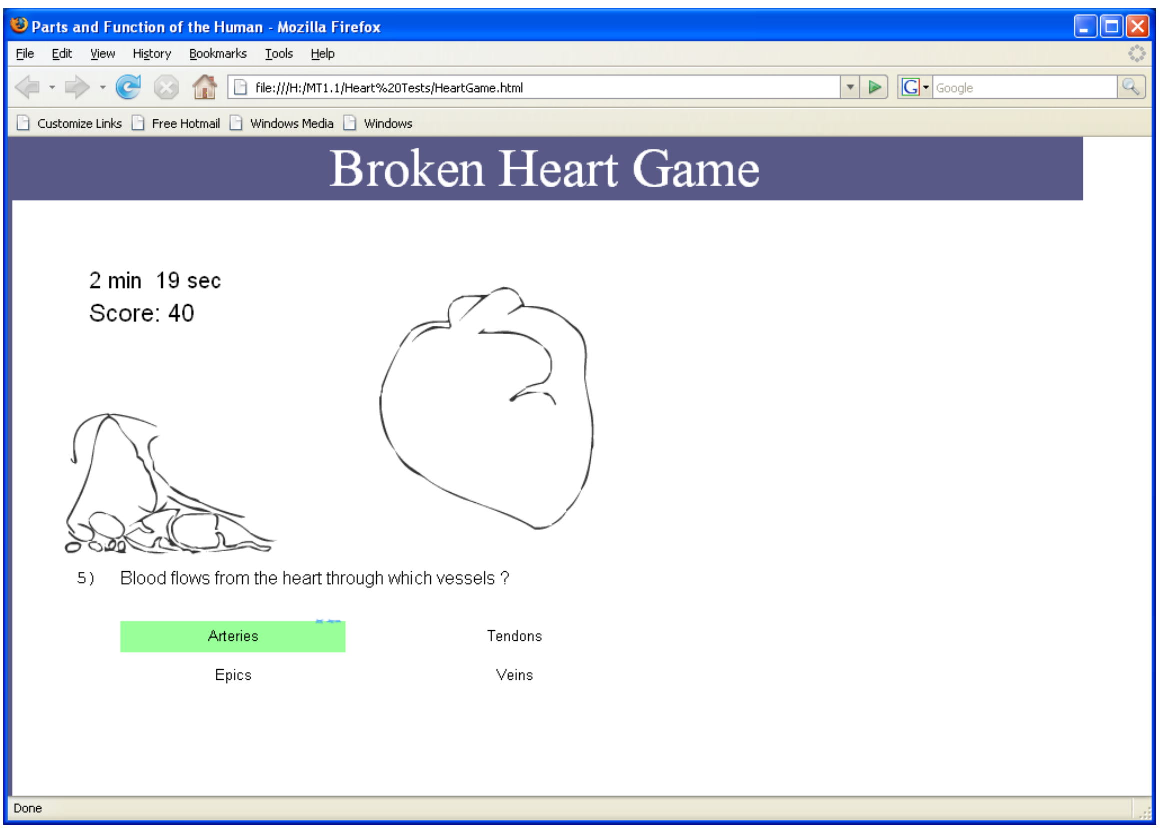

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
Ready ?
Done

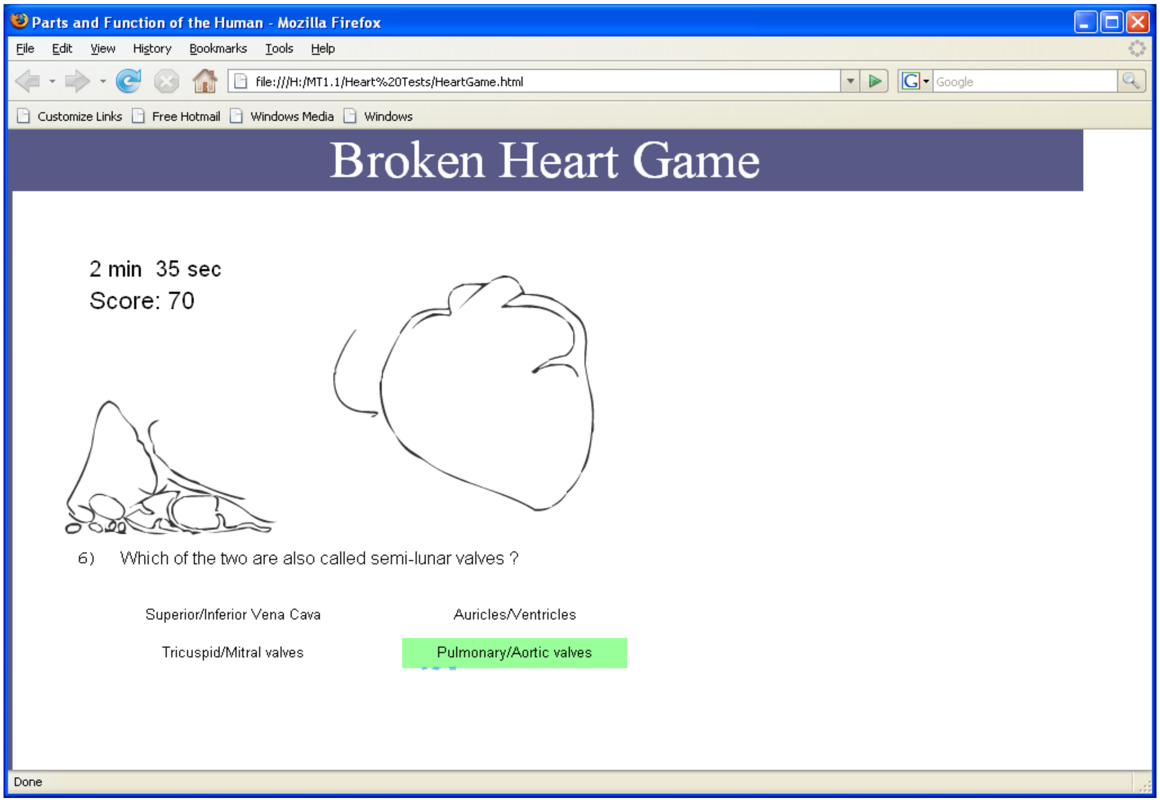

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
7 sec
Score: 10
1) When blood entering through the pulmonary veins, it also enters through the ...
Aorta
Vena Cavas
Tricuspid Valve
Mitral Valve
Done

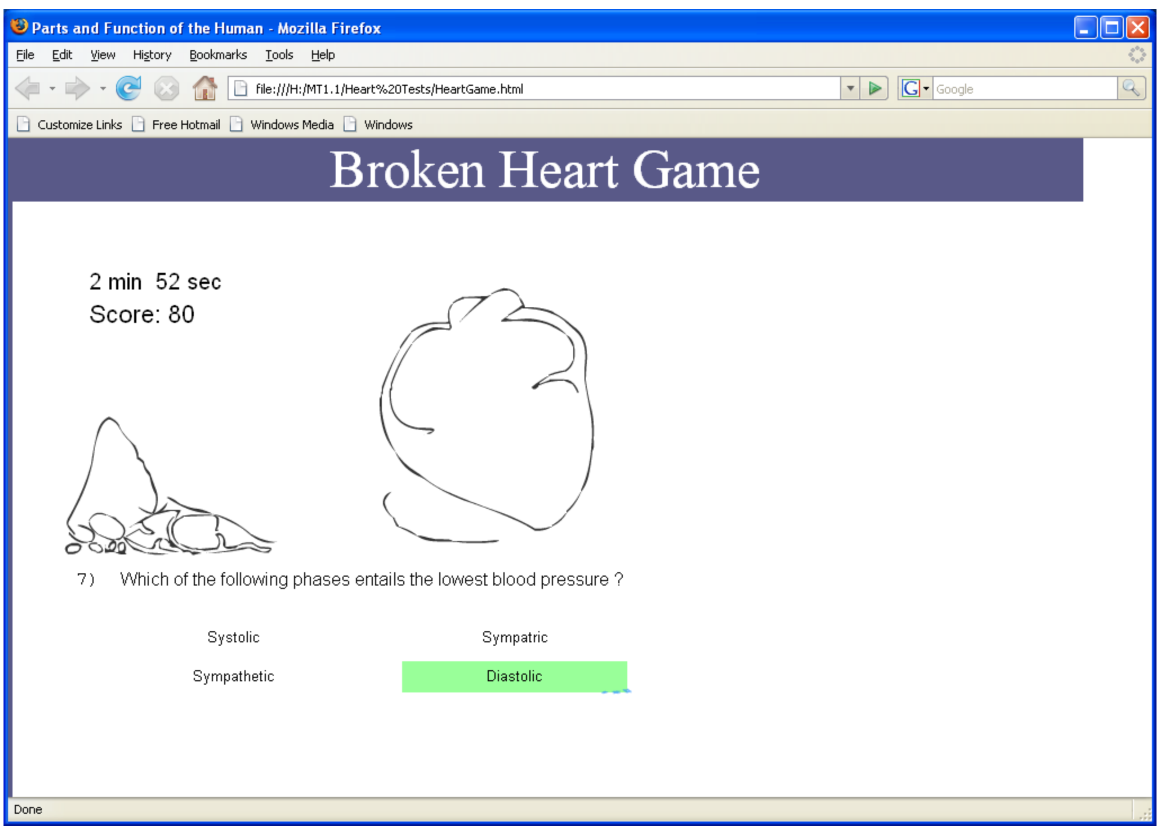

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
1 min 14 sec
Score: 10
2) Blood is carried away from the heart to the lungs by the ...
Aortic Valve
Pulmonary Valve
Pulmonary Artery
Aorta
Done

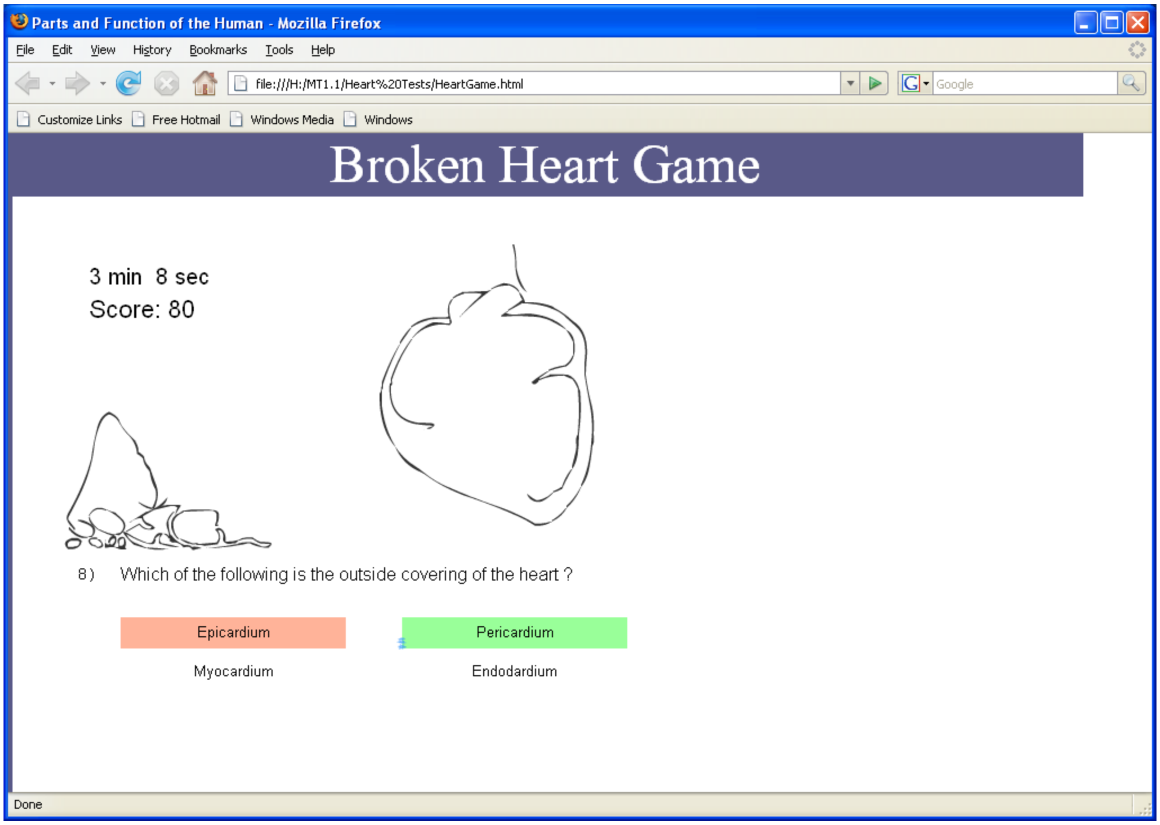

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
1 min 38 sec
Score: 20
3) Which chambers of the heart have the thickest walls ?
Pericardium
Auricles
Epicardium
Ventricles
Done

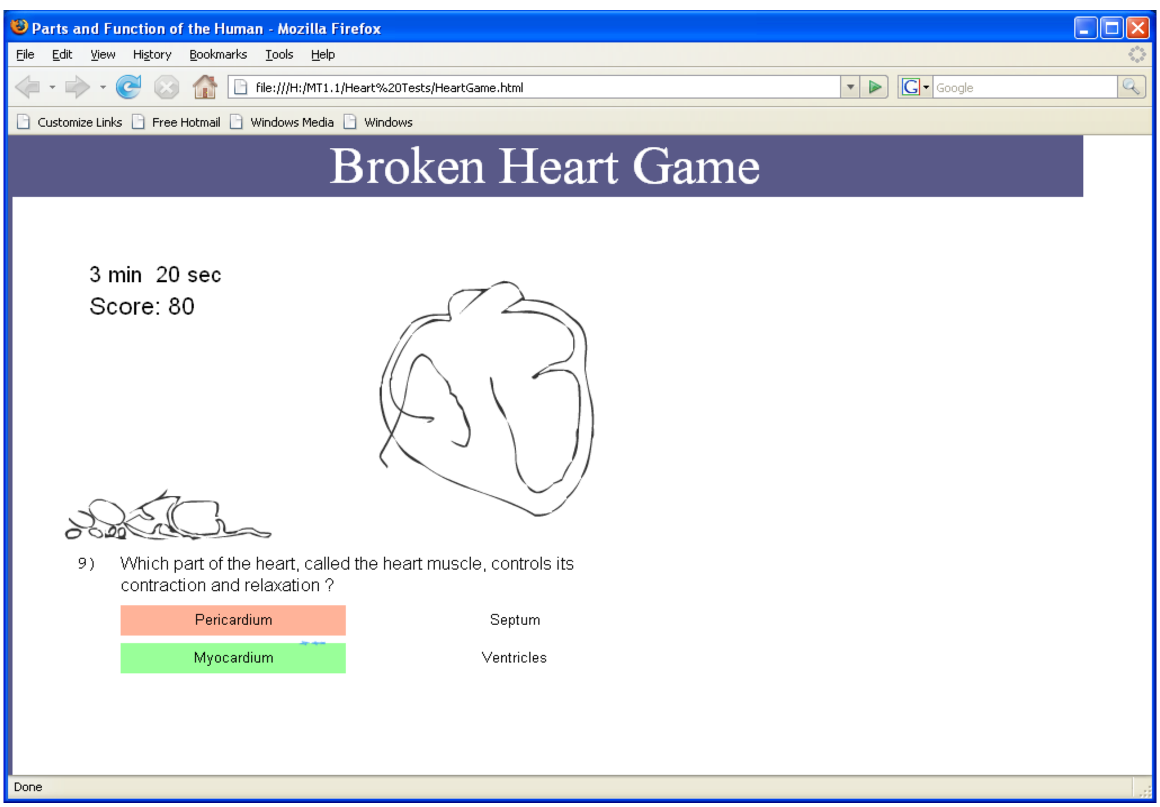

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
2 min 4 sec
Score: 30
4) Blood goes out of the pulmonary arteries while it is also going out of the ...
Pulmonary Veins
Aorta
Cardiac Artery
Superior Vena Cava
Done

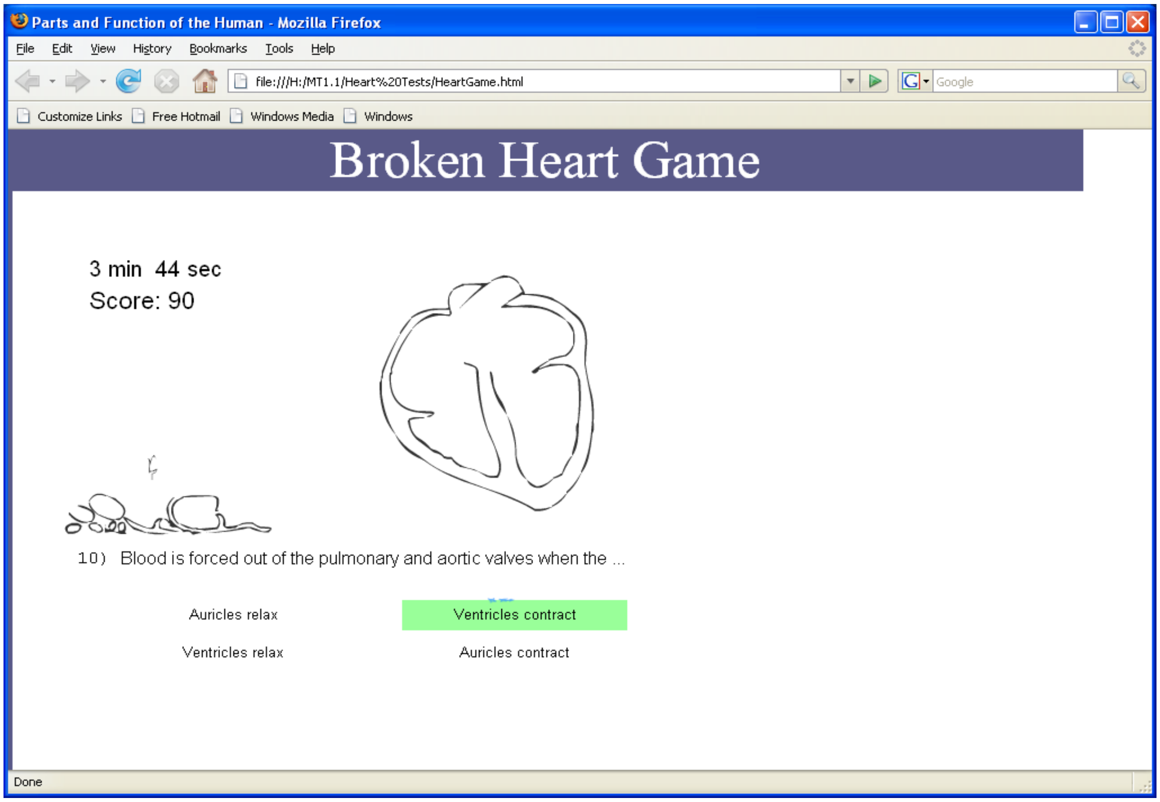

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
2 min 19 sec
Score: 40
5) Blood flows from the heart through which vessels ?
Arteries
Tendons
Epics
Veins
Done

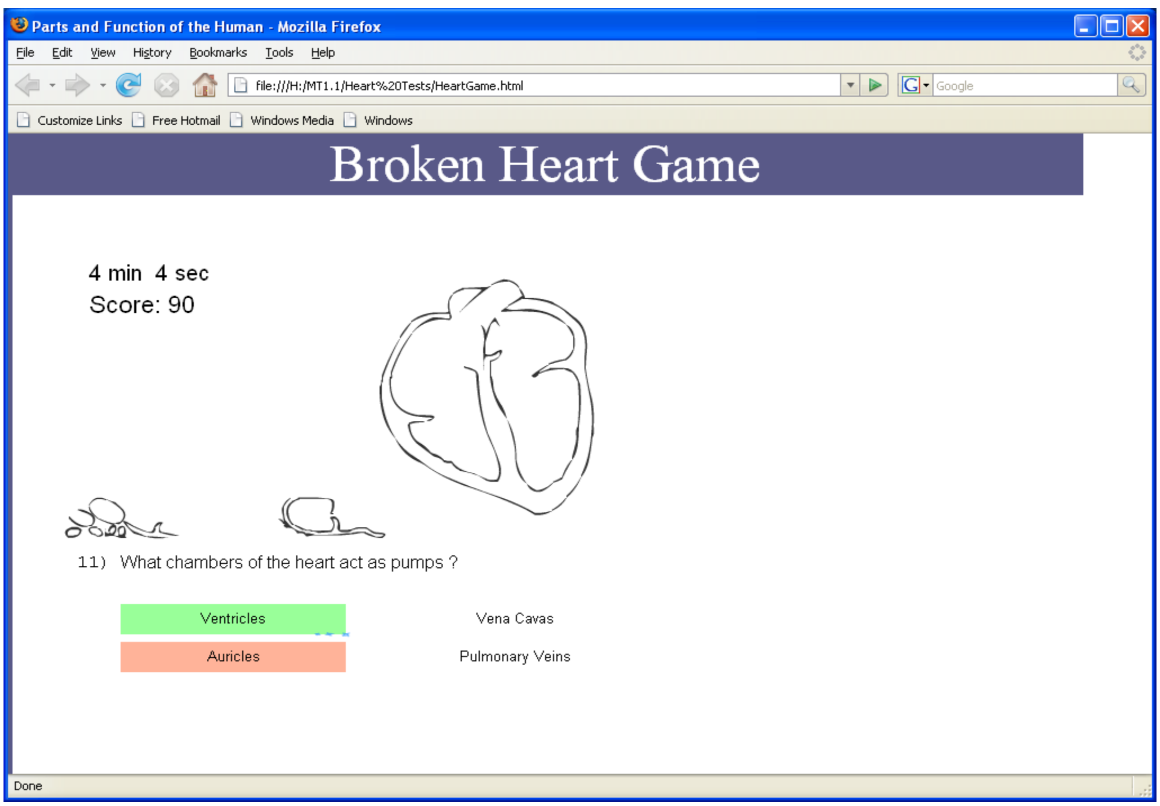

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
2 min 35 sec
Score: 70
6) Which of the two are also called semi-lunar valves ?
Superior/Inferior Vena Cava
Auricles/Ventricles
Tricuspid/Mitral valves
Pulmonary/Aortic valves
Done

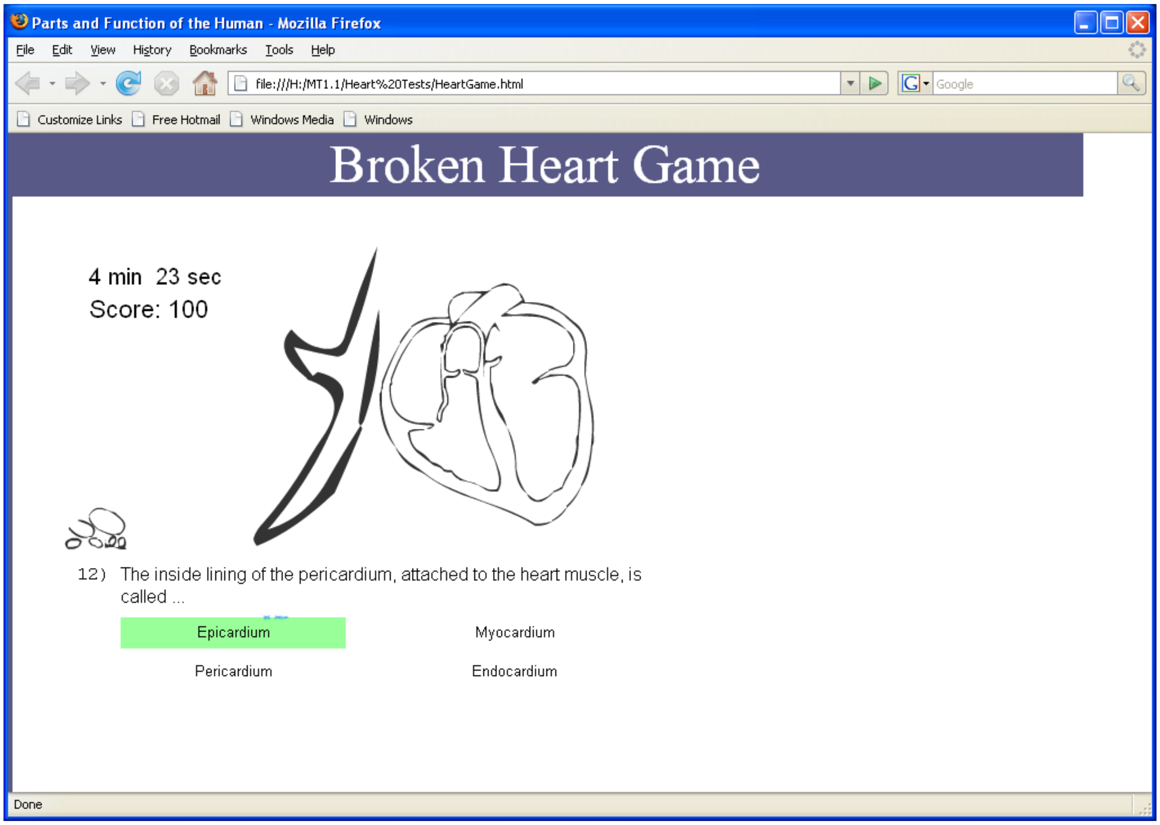

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
2 min 52 sec
Score: 80
7) Which of the following phases entails the lowest blood pressure ?
Systolic
Sympatric
Sympathetic
Diastolic
Done

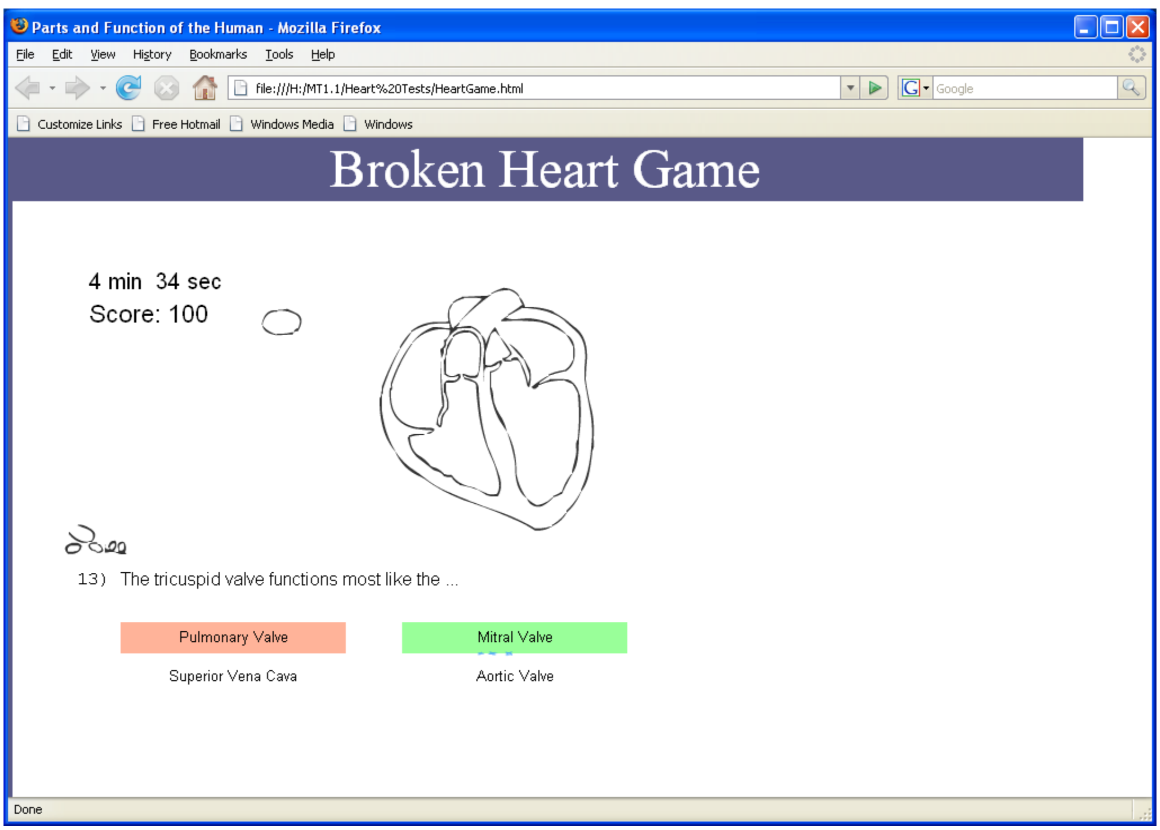

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
3 min 8 sec
Score: 80
8) Which of the following is the outside covering of the heart ?
Epicardium
Pericardium
Myocardium
Endodardium
Done

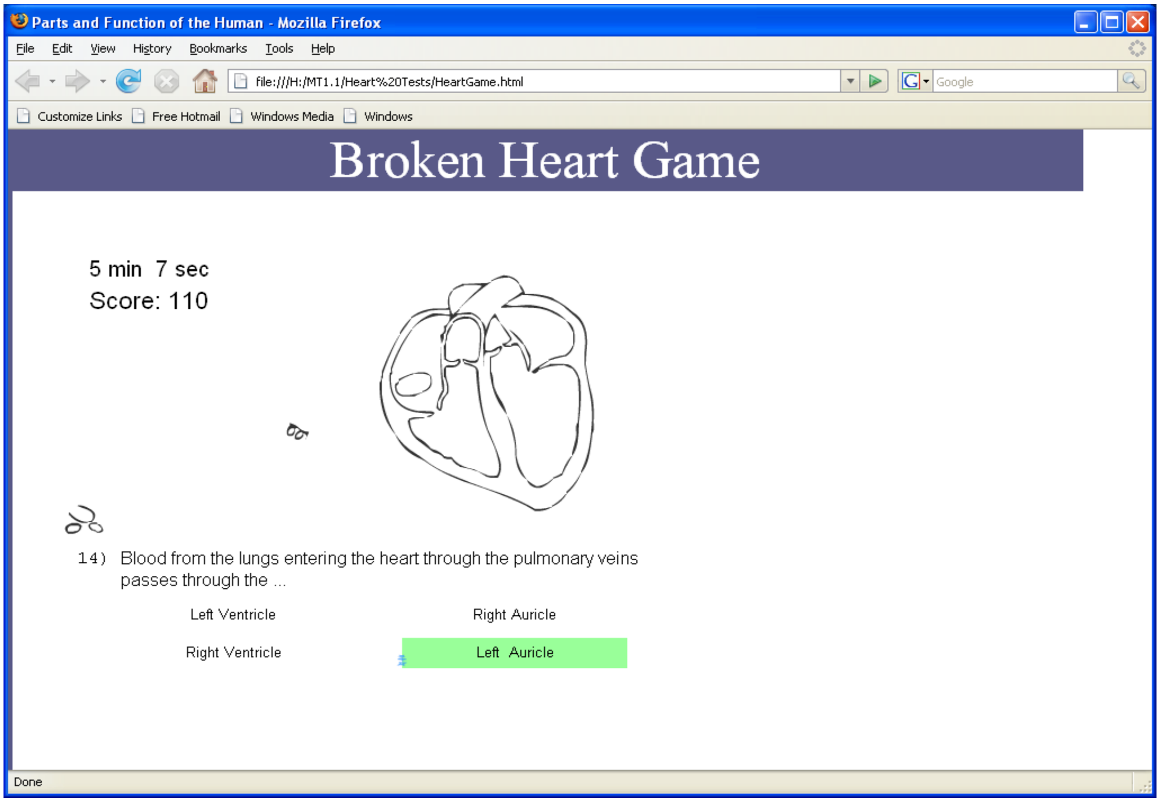

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
3 min 20 sec
Score: 80
9) Which part of the heart, called the heart muscle, controls its contraction and relaxation ?
Pericardium
Septum
Myocardium
Ventricles
Done

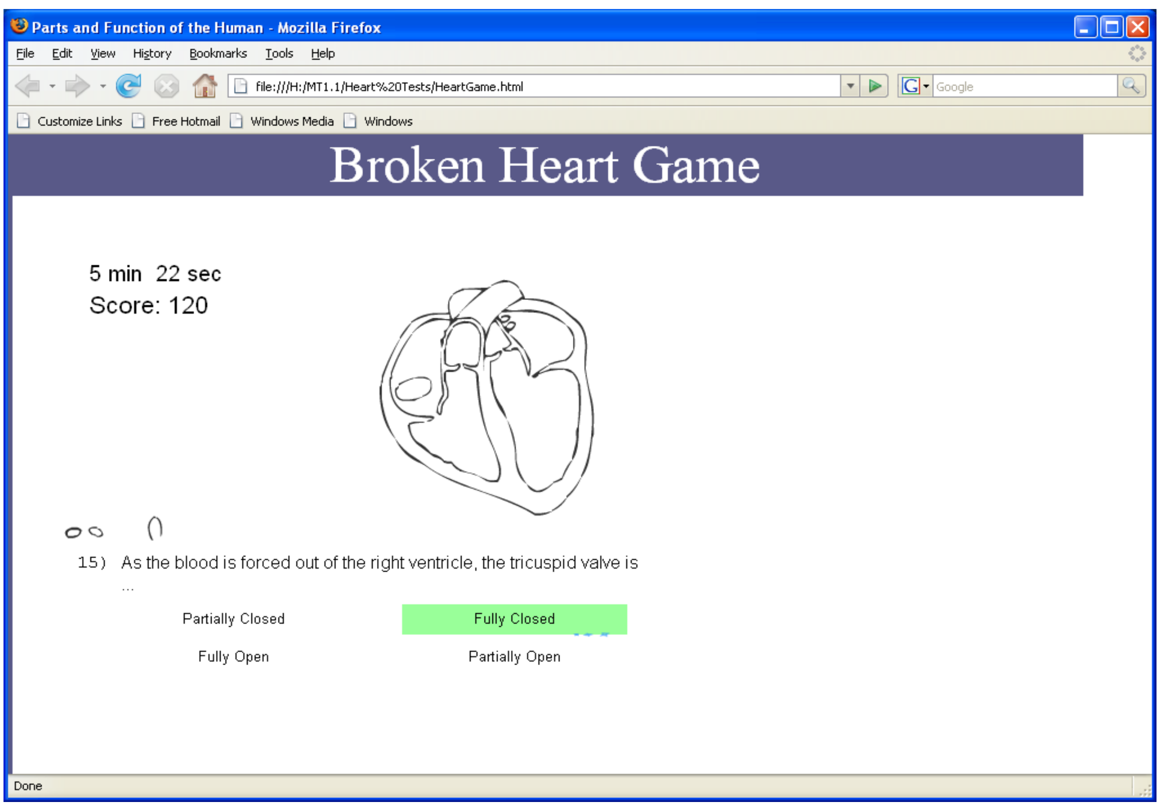

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
3 min 44 sec
Score: 90
10) Blood is forced out of the pulmonary and aortic valves when the ...
Auricles relax
Ventricles contract
Ventricles relax
Auricles contract
Done

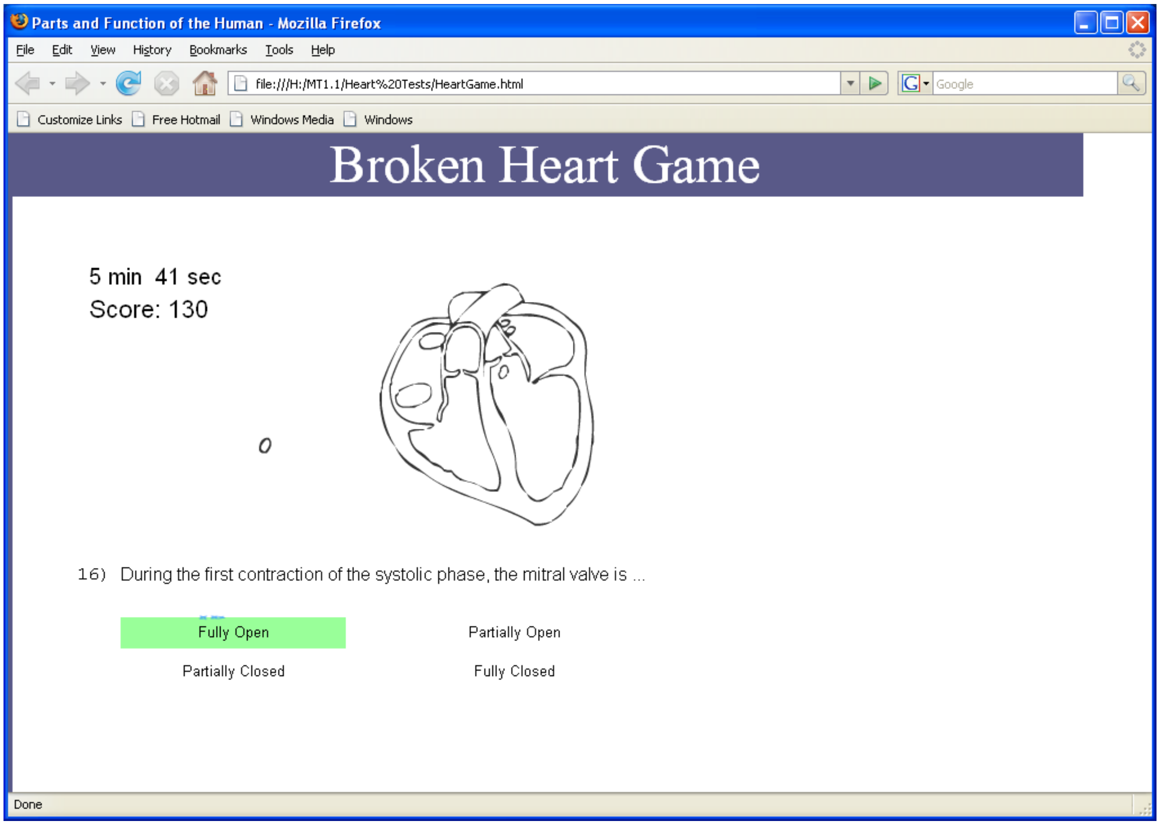

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
4 min 4 sec
Score: 90
11) What chambers of the heart act as pumps ?
Ventricles
Vena Cavas
Auricles
Pulmonary Veins
Done

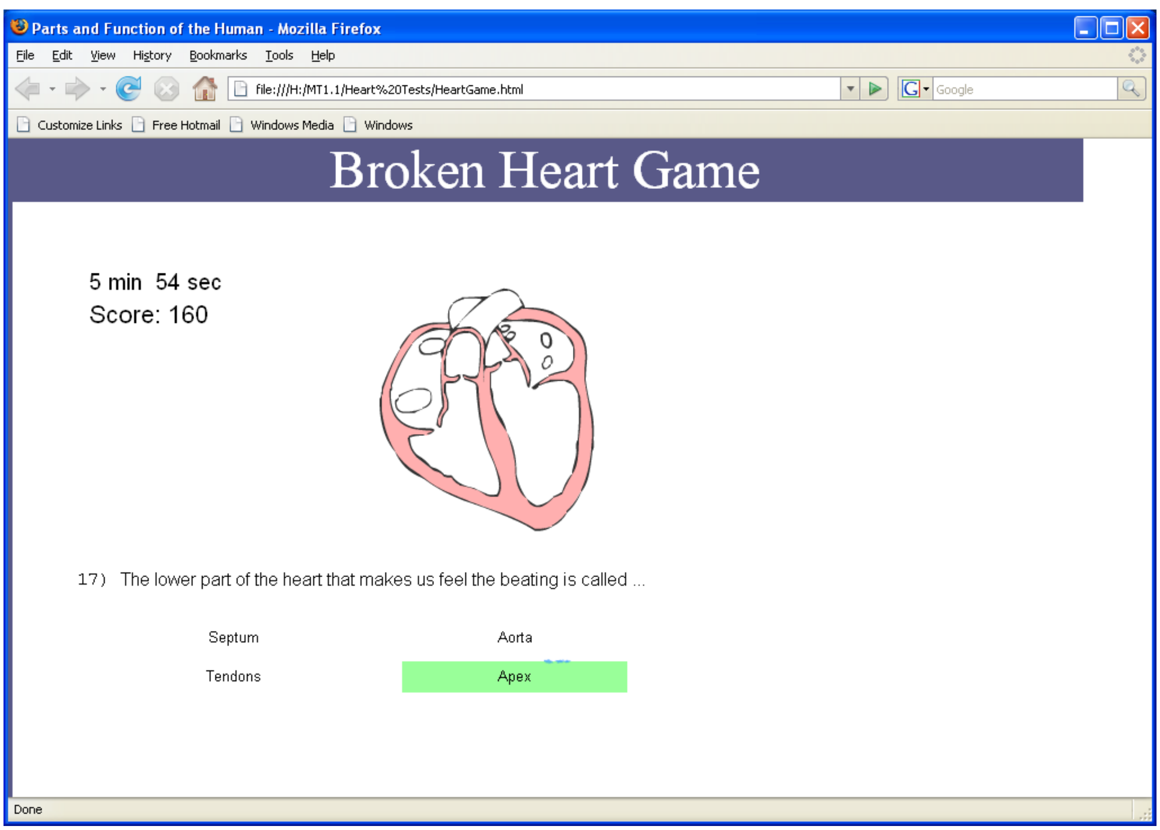

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Broken Heart Game
4 min 23 sec
Score: 100
12) The inside lining of the pericardium, attached to the heart muscle, is called ...
Epicardium
Myocardium
Pericardium
Endocardium
Done

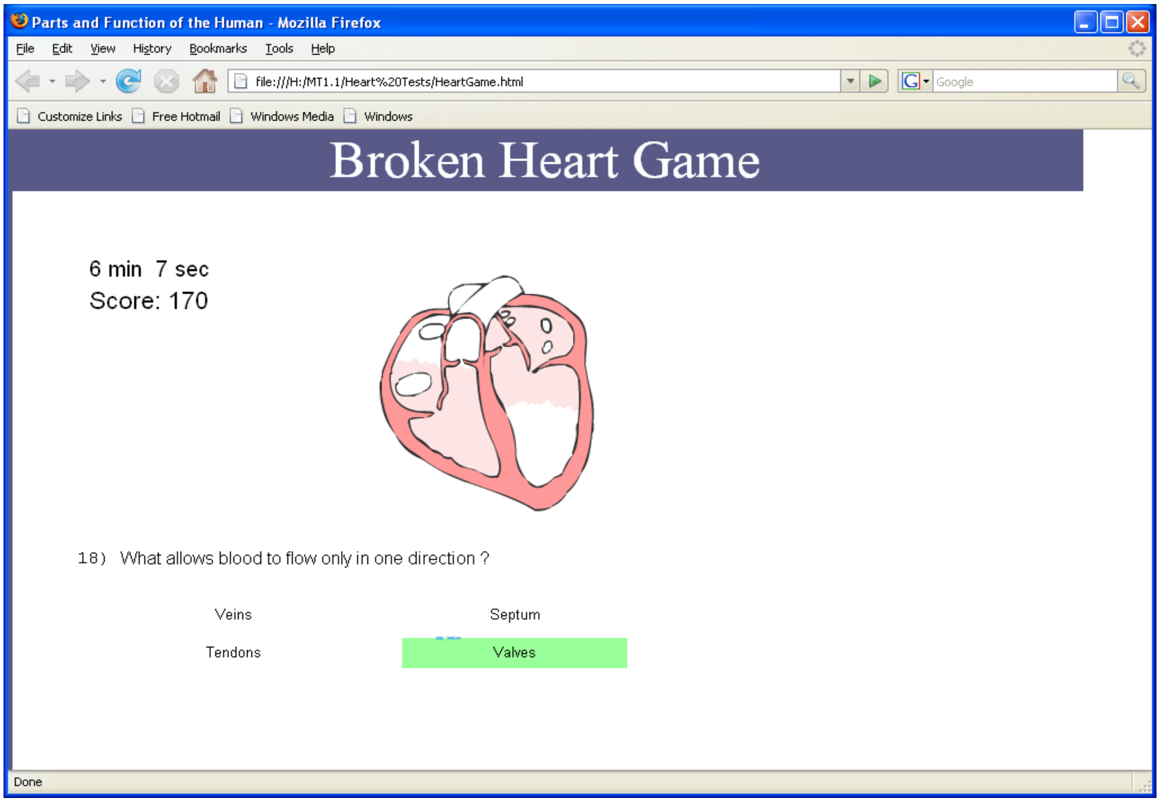

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links
Free Hotmail
Windows Media
Windows
Broken Heart Game
4 min 34 sec
Score: 100
13) The tricuspid valve functions most like the ...
Pulmonary Valve
Mitral Valve
Superior Vena Cava
Aortic Valve
Done

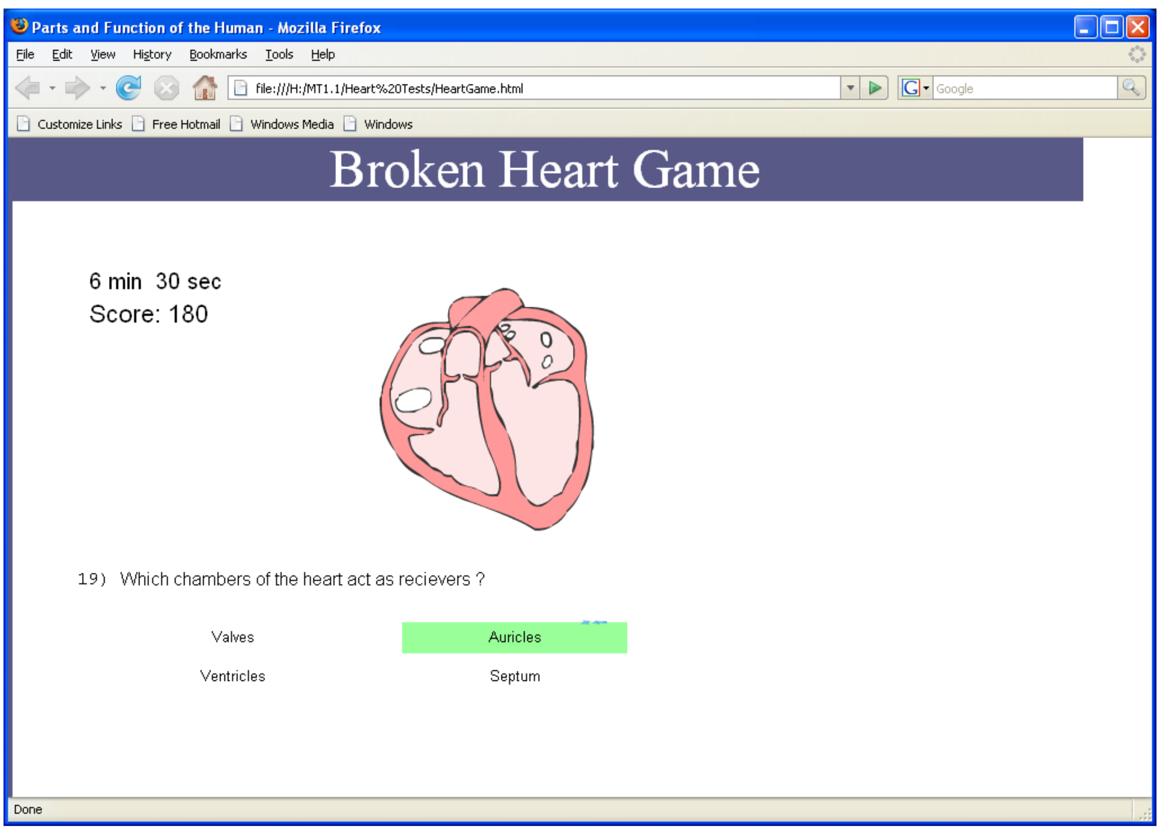

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
5 min 7 sec
Score: 110
14) Blood from the lungs entering the heart through the pulmonary veins passes through the ...
Left Ventricle
Right Auricle
Right Ventricle
Left Auricle
Done

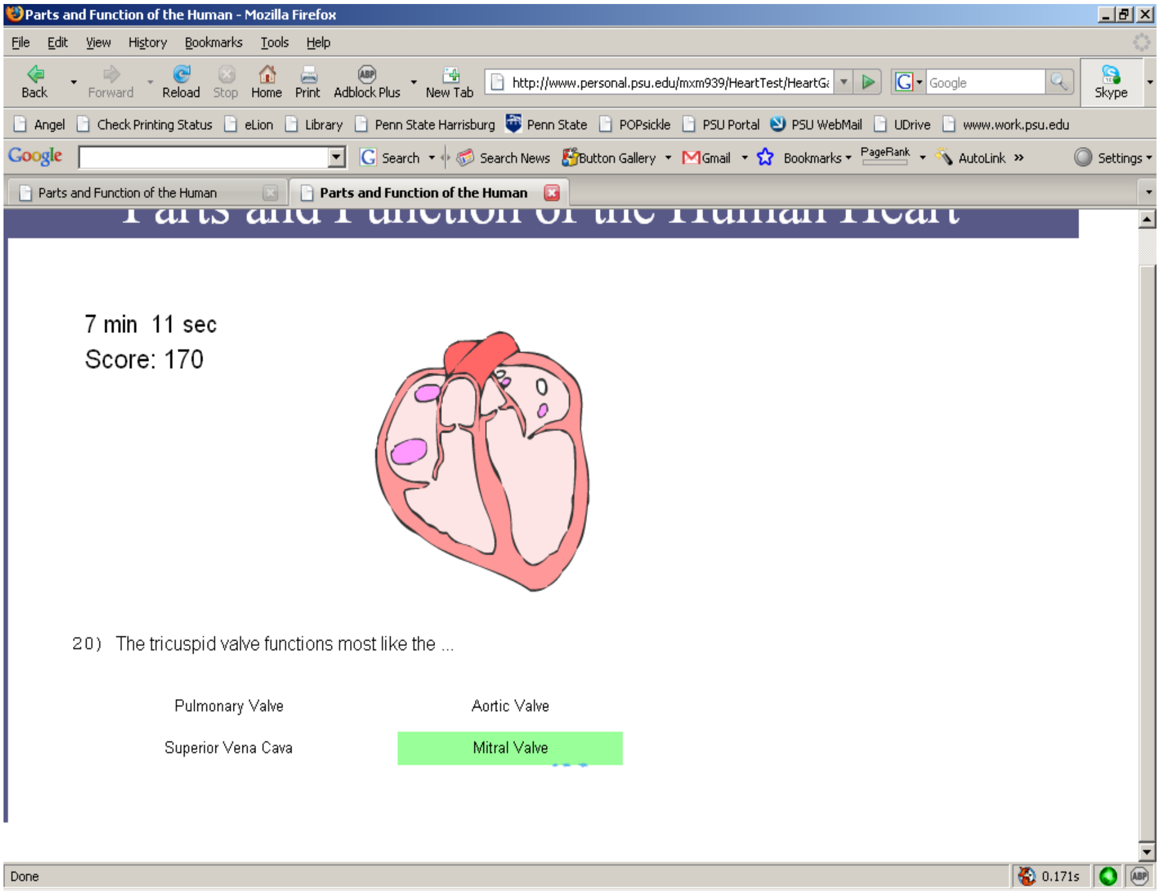

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
5 min 22 sec
Score: 120
15) As the blood is forced out of the right ventricle, the tricuspid valve is ...
Partially Closed
Fully Closed
Fully Open
Partially Open
Done

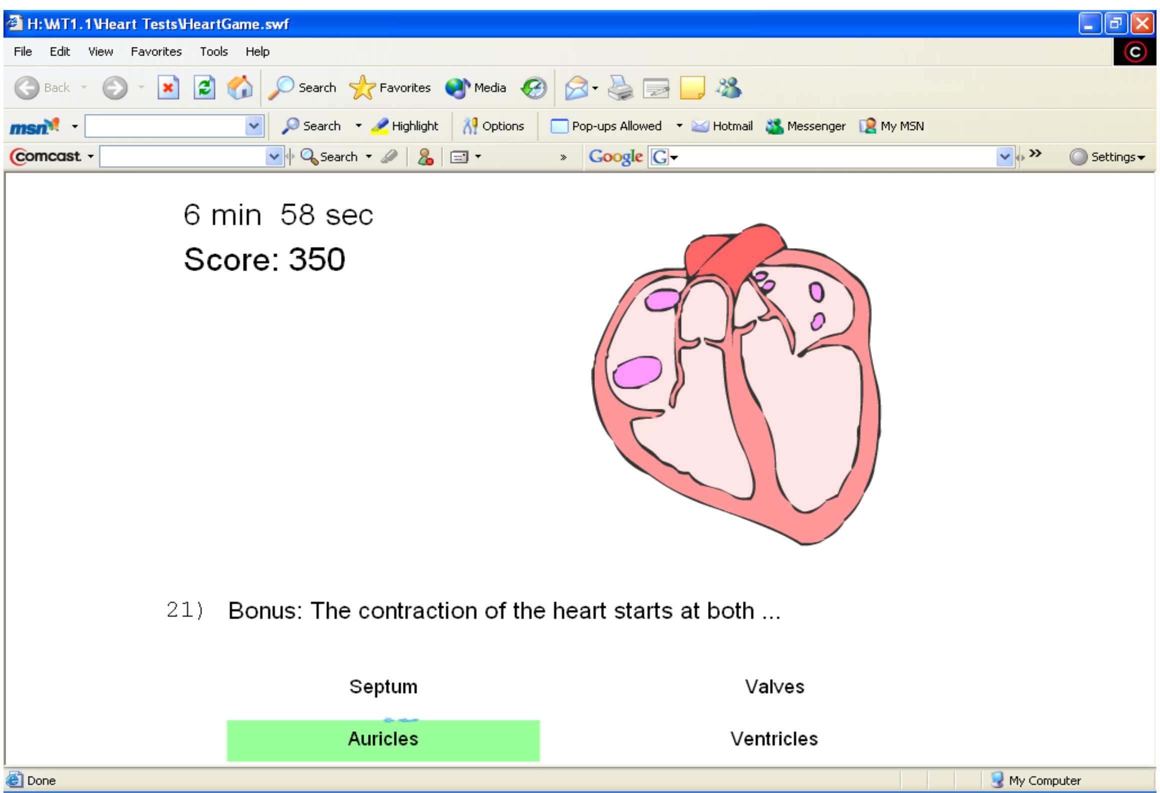

Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
5 min 41 sec
Score: 130
16) During the first contraction of the systolic phase, the mitral valve is ...
Fully Open
Partially Open
Partially Closed
Fully Closed
Done


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
5 min 54 sec
Score: 160
17) The lower part of the heart that makes us feel the beating is called ...
Septum
Aorta
Tendons
Apex
Done


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
6 min 7 sec
Score: 170
18) What allows blood to flow only in one direction ?
Veins
Septum
Tendons
Valves
Done


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT1.1/Heart%20Tests/HeartGame.html
Google
Customize Links Free Hotmail Windows Media Windows
Broken Heart Game
6 min 30 sec
Score: 180
19) Which chambers of the heart act as recievers ?
Valves
Auricles
Ventricles
Septum
Done

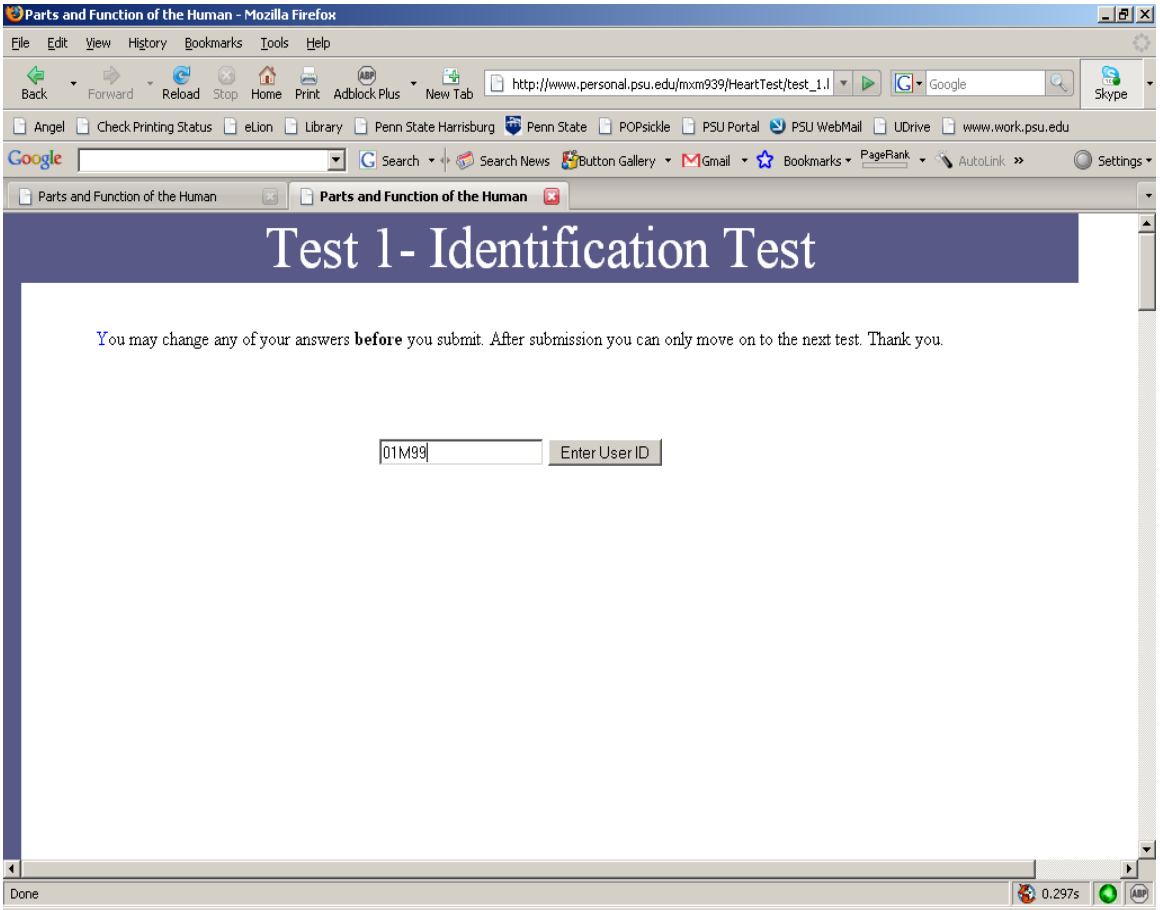

Parts and Function of the Human - Mozilla Firefox
7 min 11 sec
Score: 170
20) The tricuspid valve functions most like the ...
Pulmonary Valve
Aortic Valve
Superior Vena Cava
Mitral Valve
Done

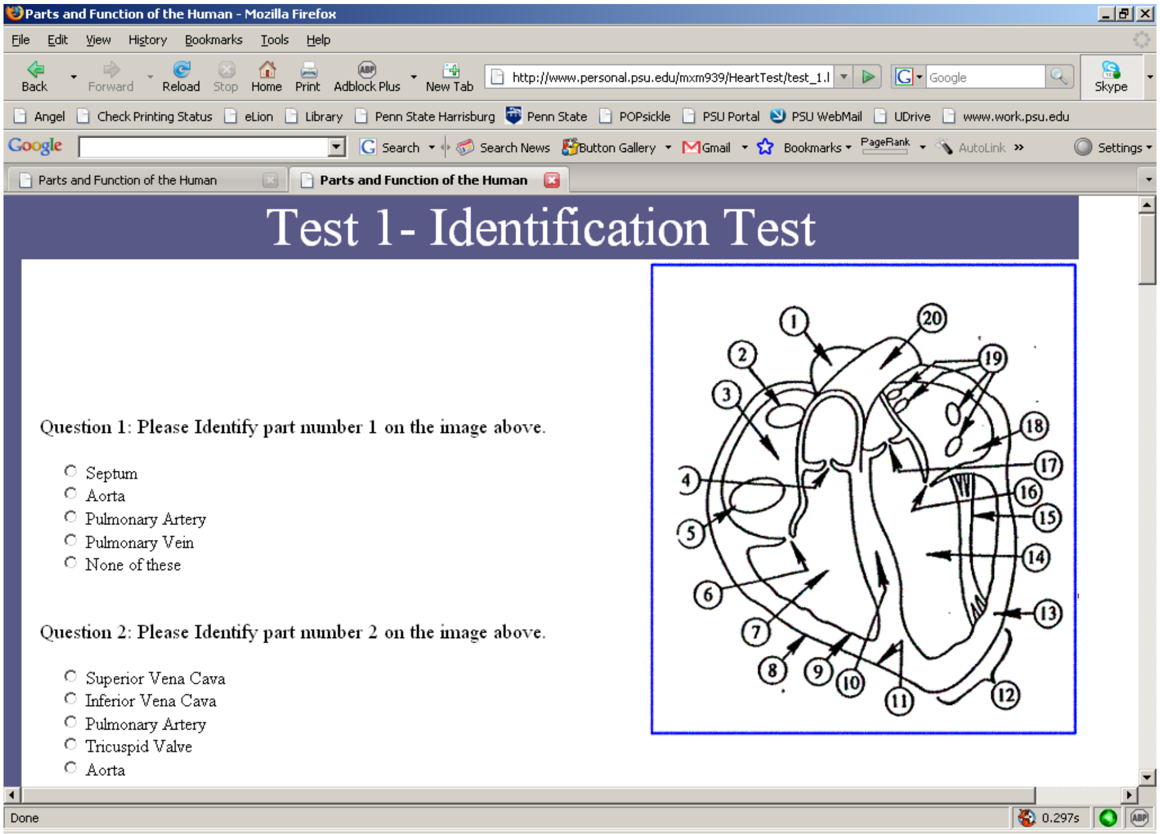

H:\MT1.1\Heart Tests\HeartGame.swf
6 min 58 sec
Score: 350
21) Bonus: The contraction of the heart starts at both ...
Septum
Valves
Auricles
Ventricles
Done

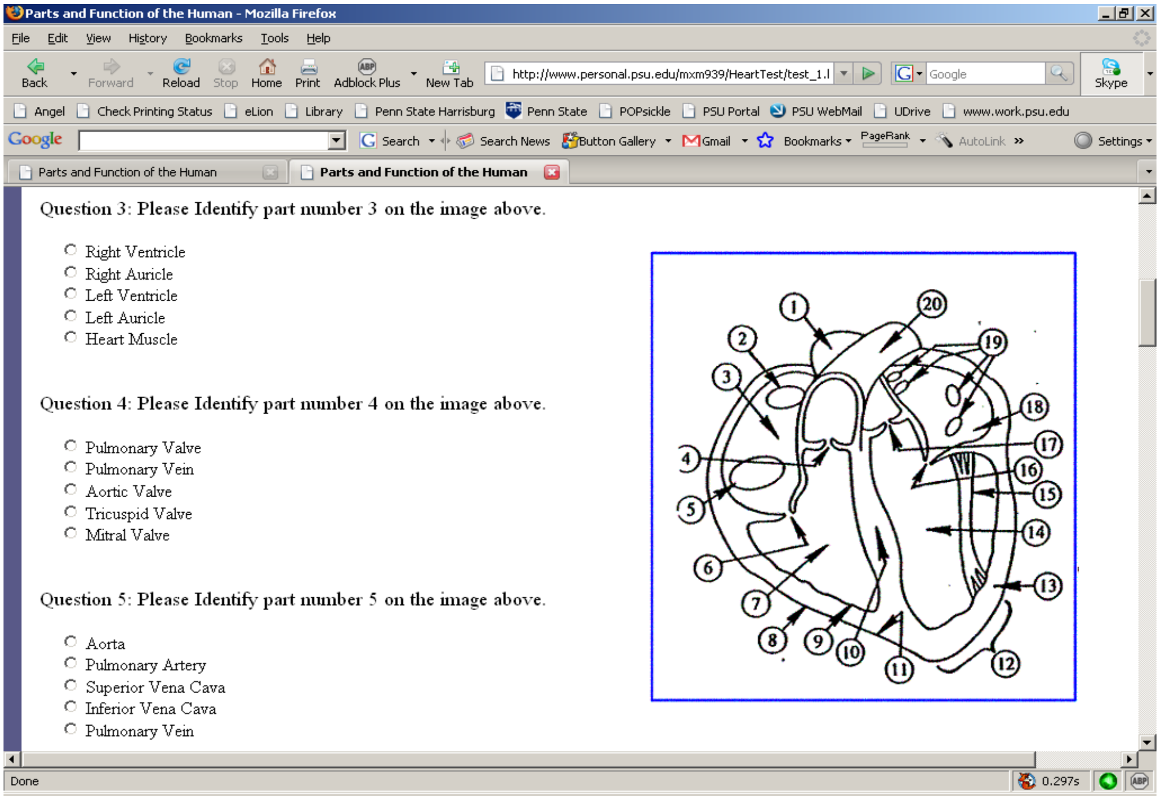
Appendix E

Criterion Measures

Identification Test



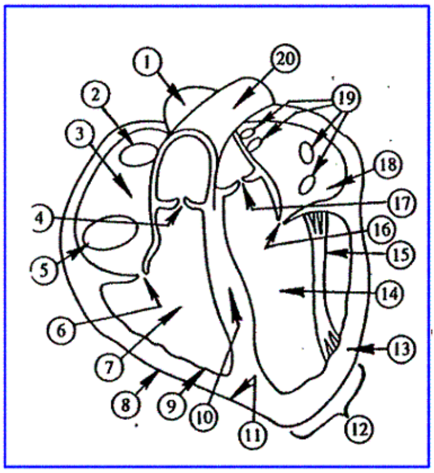

Parts and Function of the Human - Mozilla Firefox
http://www.personal.psu.edu/mxm939/HeartTest/test_1.l
Test 1- Identification Test
Question 1: Please Identify part number 1 on the image above.
Septum
Aorta
Pulmonary Artery
Pulmonary Vein
None of these
Question 2: Please Identify part number 2 on the image above.
Superior Vena Cava
Inferior Vena Cava
Pulmonary Artery
Tricuspid Valve
Aorta
Done


Parts and Function of the Human - Mozilla Firefox
http://www.personal.psu.edu/mxm939/HeartTest/test_1.l
Question 3: Please Identify part number 3 on the image above.
Right Ventricle
Right Auricle
Left Ventricle
Left Auricle
Heart Muscle
Question 4: Please Identify part number 4 on the image above.
Pulmonary Valve
Pulmonary Vein
Aortic Valve
Tricuspid Valve
Mitral Valve
Question 5: Please Identify part number 5 on the image above.
Aorta
Pulmonary Artery
Superior Vena Cava
Inferior Vena Cava
Pulmonary Vein
Done

Parts and Function of the Human - Mozilla Firefox

Question 6: Please Identify part number 6 on the image above.

- Aortic Valve
- Pulmonary Valve
- Mitral Valve
- Tricuspid Valve
- Semi-lunar Valve



Question 7: Please Identify part number 7 on the image above.

- Left Ventricle
- Right Ventricle
- Right Auricle
- Left Auricle
- Vascular Space

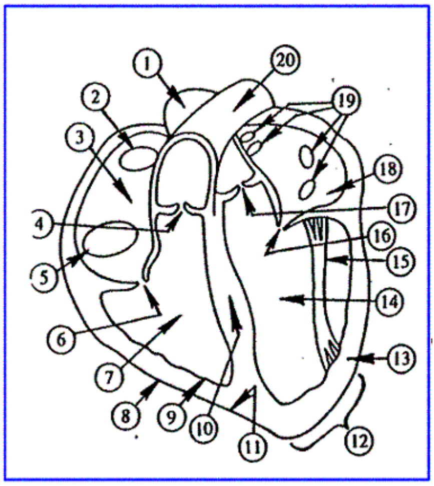
Question 8: Please Identify part number 8 on the image above.

- Myocardium
- Ectoderm
- Pericardium
- Endocardium
- Epicardium

Parts and Function of the Human - Mozilla Firefox

Question 9: Please Identify part number 9 on the image above.

- Endocardium
- Myocardium
- Pericardium
- Ectoderm
- Septum



Question 10: Please Identify part number 10 on the image above.

- Endocardium
- Pericardium
- Septum
- Myocardium
- Aortic Base

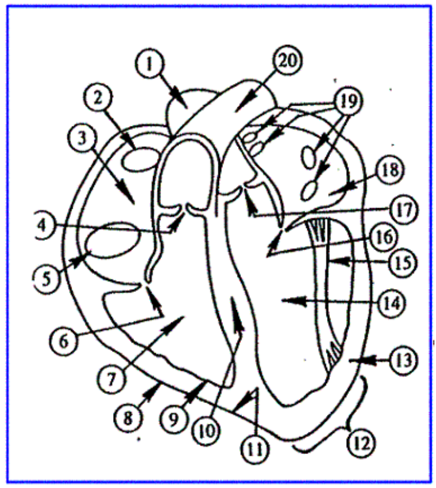
Question 11: Please Identify part number 11 on the image above.

- Epicardium
- Pericardium
- Endocardium
- Myocardium
- None of these

Parts and Function of the Human - Mozilla Firefox

Question 12: Please Identify part number 12 on the image above.

- Pericardium
- Myocardium
- Endocardium
- Endoderm
- Apex



Question 13: Please Identify part number 13 on the image above.

- Pericardium
- Endocardium
- Ectocardium
- Endoderm
- Myocardium

Question 14: Please Identify part number 14 on the image above.

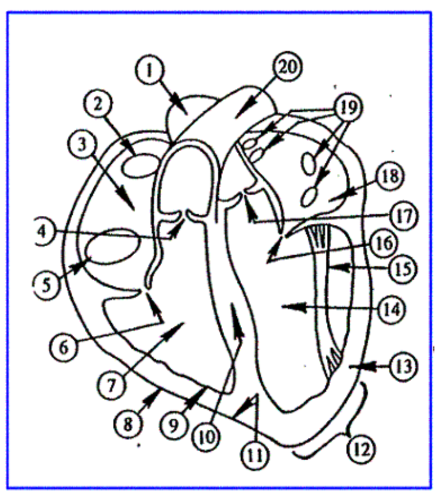
- Right Ventricle
- Left Ventricle
- Left Auricle
- Right Auricle
- Apex

Done

Parts and Function of the Human - Mozilla Firefox

Question 15: Please Identify part number 15 on the image above.

- Pulmonary Veins
- Tendons
- Aortas
- Pericardium
- None of these



Question 16: Please Identify part number 16 on the image above.

- Venic Valve
- Pulmonary Valve
- Tricuspid Valve
- Mitral Valve
- Aortic Valve

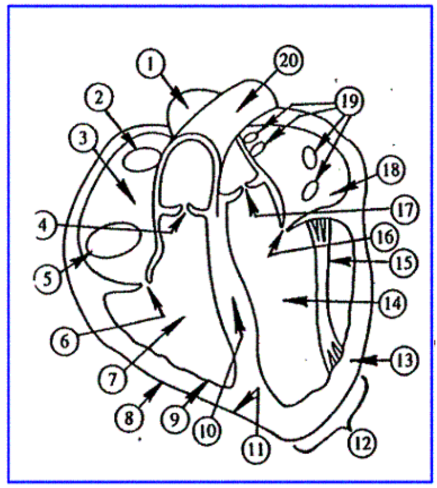
Question 17: Please Identify part number 17 on the image above.

- Superior Vena Cava
- Tricuspid Valve
- Aortic Valve
- Pulmonary Valve
- Mitral Valve

Done

Question 18: Please Identify part number 18 on the image above.

- Right Auricle
- Right Ventricle
- Left Auricle
- Left Ventricle
- Semi-lunar Chamber



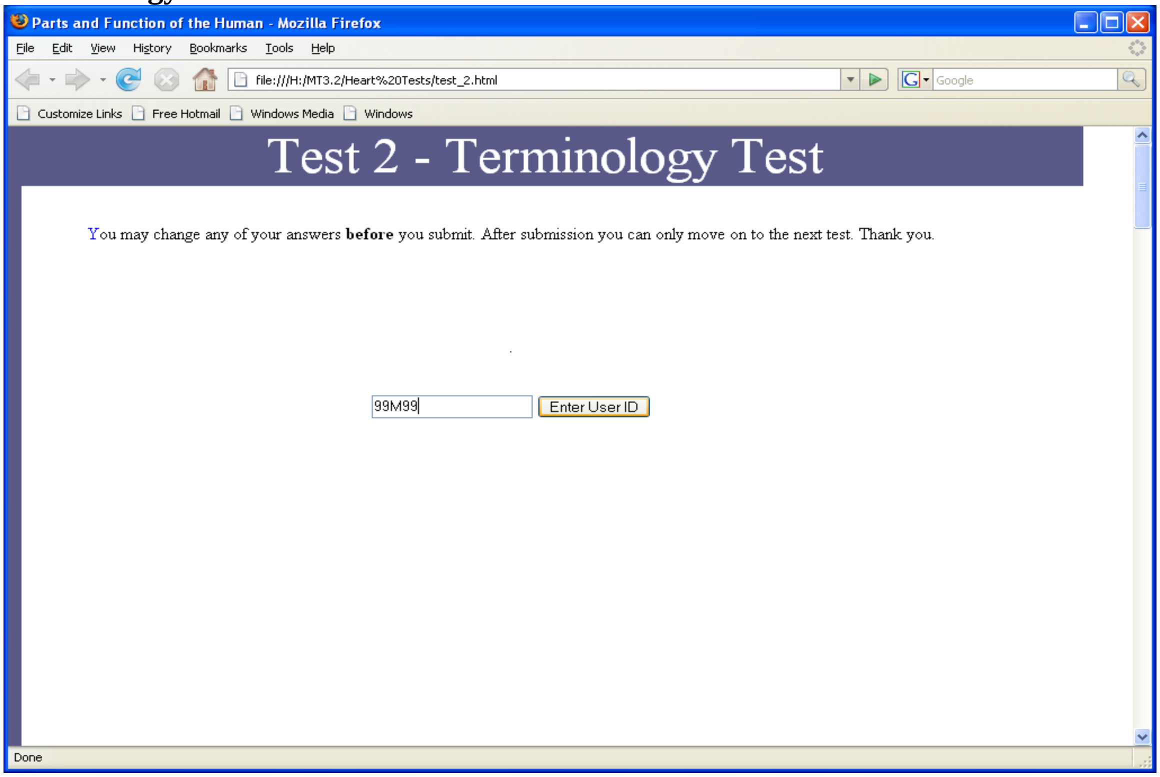
Question 19: Please Identify part number 19 on the image above.

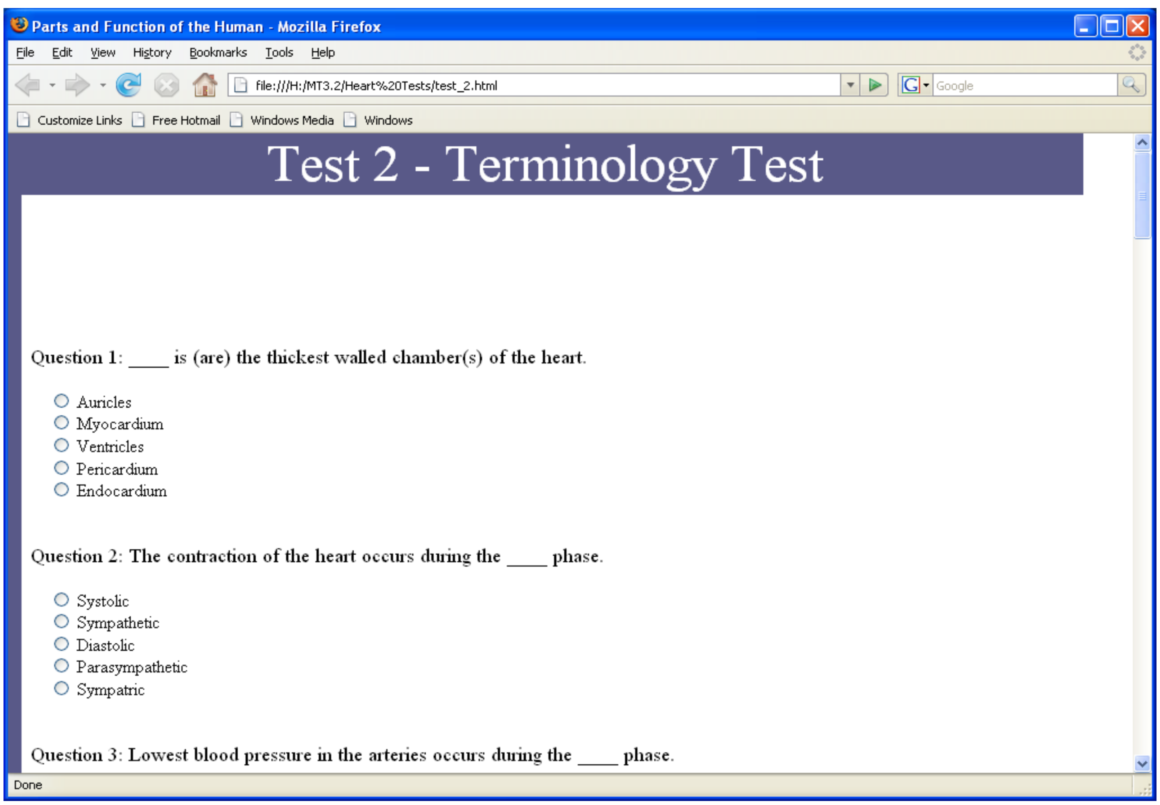
- Inferior Vena Cava
- Superior Vena Cava
- Aortas
- Pulmonary Veins
- Pulmonary Arteries

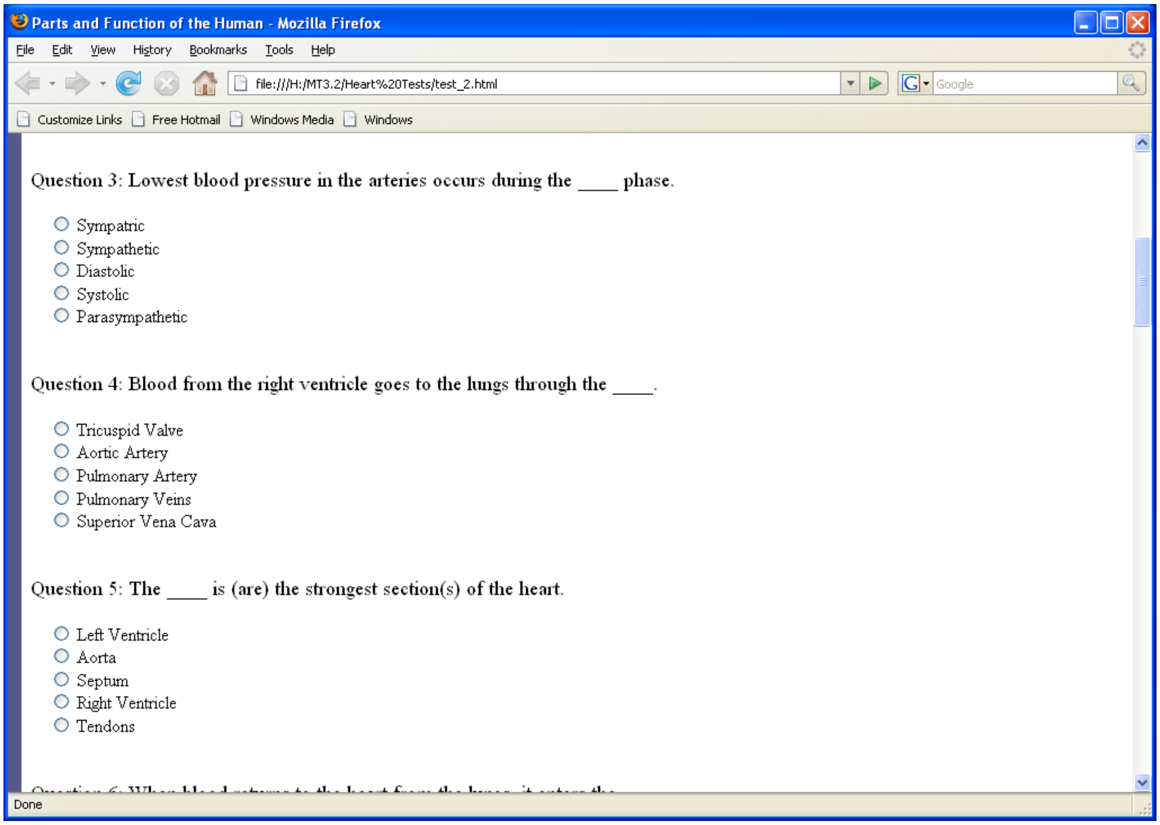
Question 20: Please Identify part number 20 on the image above.

- Inferior Vena Cava
- Aorta
- Pulmonary Artery
- Septum
- Superior Vena Cava

Terminology Test







Question 3: Lowest blood pressure in the arteries occurs during the ____ phase.

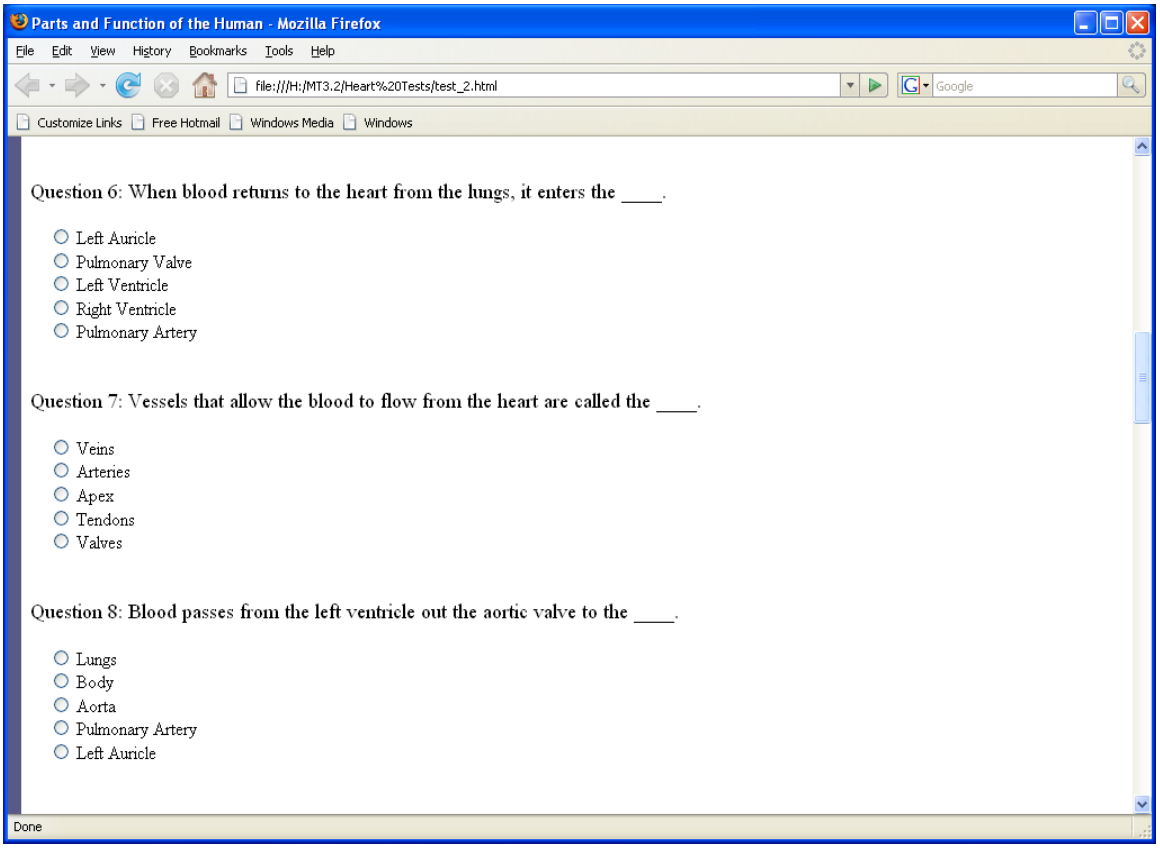
- Sympatric
- Sympathetic
- Diastolic
- Systolic
- Parasympathetic

Question 4: Blood from the right ventricle goes to the lungs through the ____.

- Tricuspid Valve
- Aortic Artery
- Pulmonary Artery
- Pulmonary Veins
- Superior Vena Cava

Question 5: The ____ is (are) the strongest section(s) of the heart.

- Left Ventricle
- Aorta
- Septum
- Right Ventricle
- Tendons



Question 6: When blood returns to the heart from the lungs, it enters the ____.

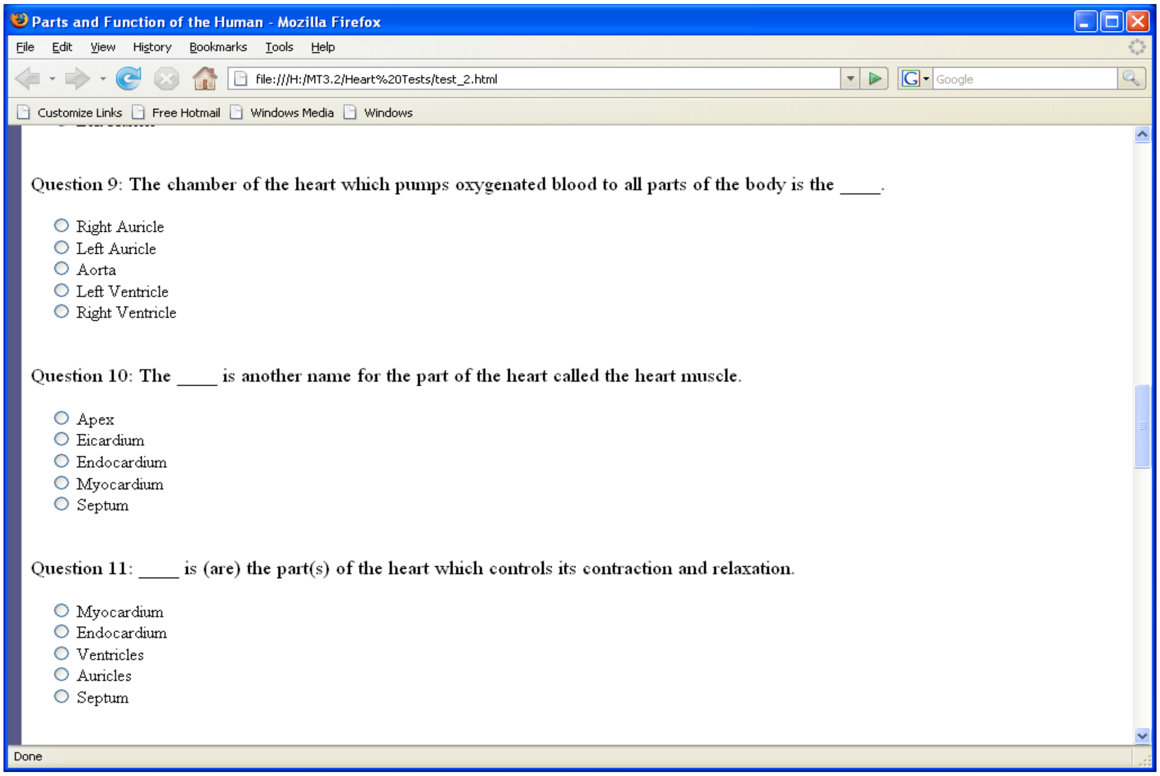
- Left Auricle
- Pulmonary Valve
- Left Ventricle
- Right Ventricle
- Pulmonary Artery

Question 7: Vessels that allow the blood to flow from the heart are called the ____.

- Veins
- Arteries
- Apex
- Tendons
- Valves

Question 8: Blood passes from the left ventricle out the aortic valve to the ____.

- Lungs
- Body
- Aorta
- Pulmonary Artery
- Left Auricle



Parts and Function of the Human - Mozilla Firefox

Question 9: The chamber of the heart which pumps oxygenated blood to all parts of the body is the ____.

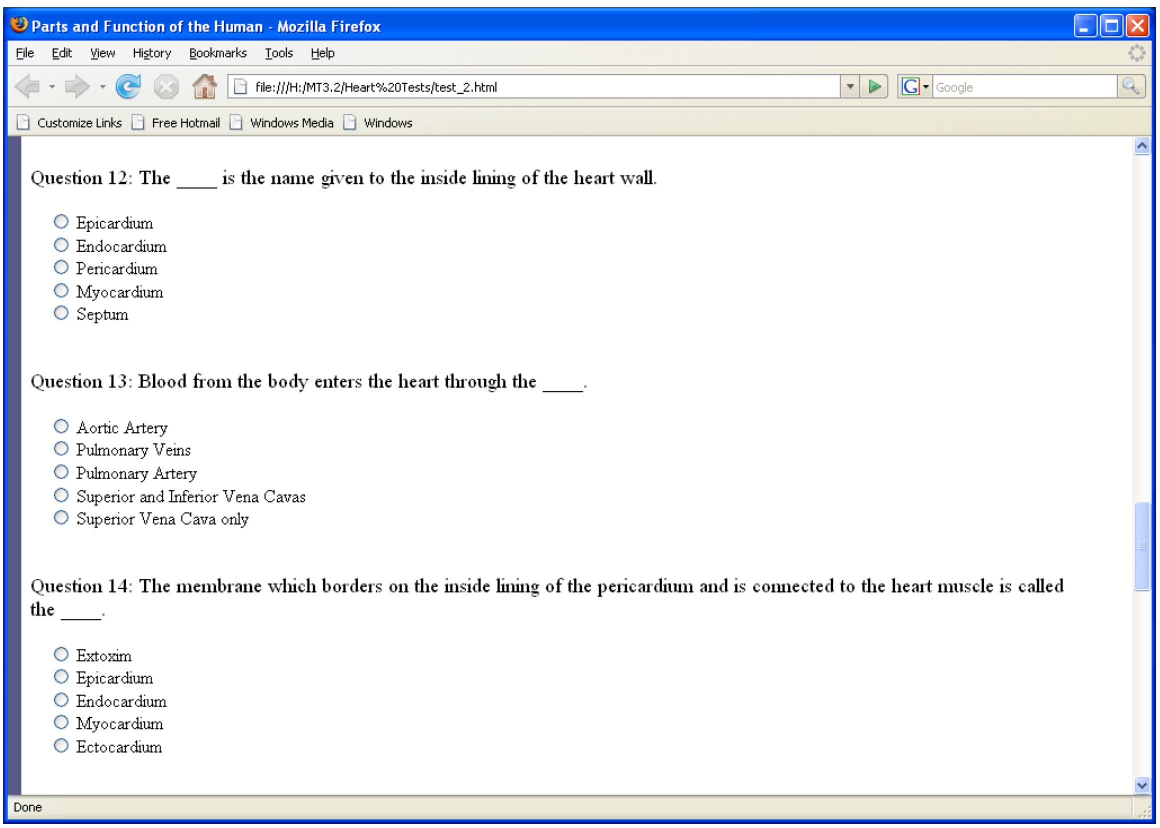
- Right Auricle
- Left Auricle
- Aorta
- Left Ventricle
- Right Ventricle

Question 10: The ____ is another name for the part of the heart called the heart muscle.

- Apex
- Eicardium
- Endocardium
- Myocardium
- Septum

Question 11: ____ is (are) the part(s) of the heart which controls its contraction and relaxation.

- Myocardium
- Endocardium
- Ventricles
- Auricles
- Septum



Parts and Function of the Human - Mozilla Firefox

Question 12: The ____ is the name given to the inside lining of the heart wall.

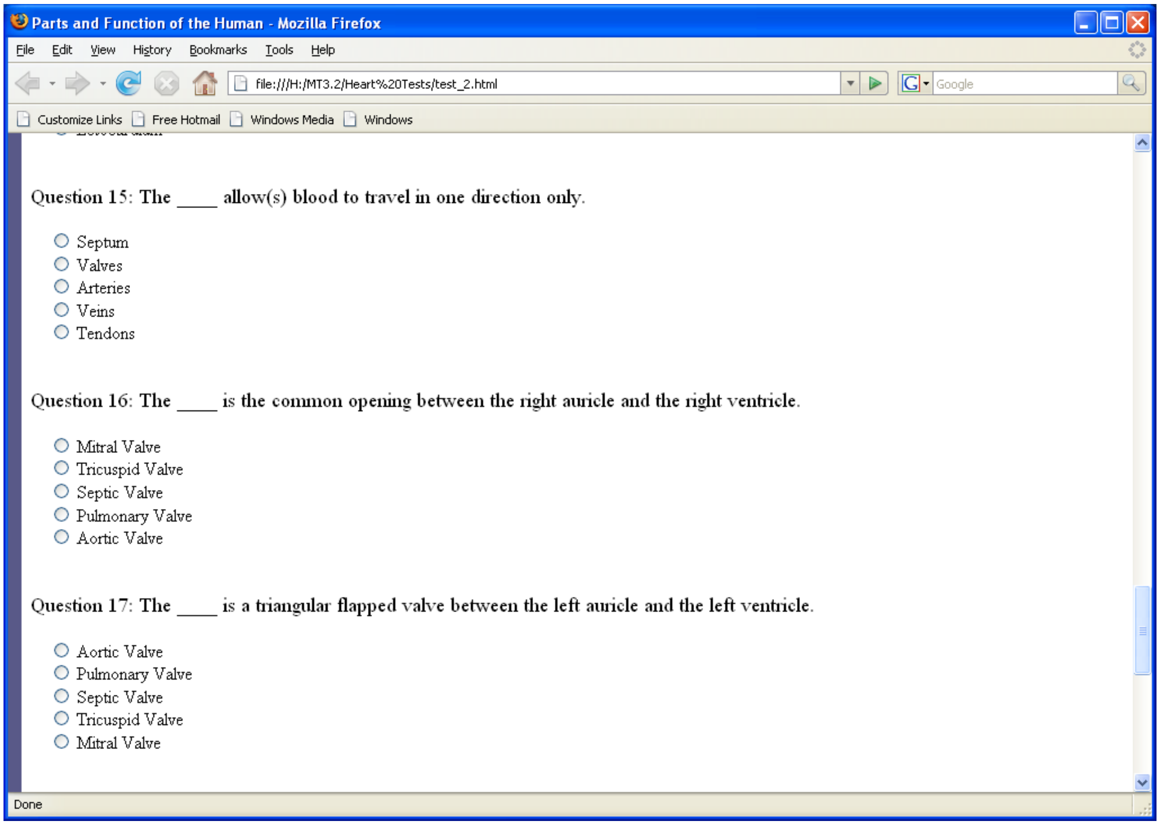
- Epicardium
- Endocardium
- Pericardium
- Myocardium
- Septum

Question 13: Blood from the body enters the heart through the ____.

- Aortic Artery
- Pulmonary Veins
- Pulmonary Artery
- Superior and Inferior Vena Cavas
- Superior Vena Cava only

Question 14: The membrane which borders on the inside lining of the pericardium and is connected to the heart muscle is called the ____.

- Extoxim
- Epicardium
- Endocardium
- Myocardium
- Ectocardium



Parts and Function of the Human - Mozilla Firefox

Question 15: The ____ allow(s) blood to travel in one direction only.

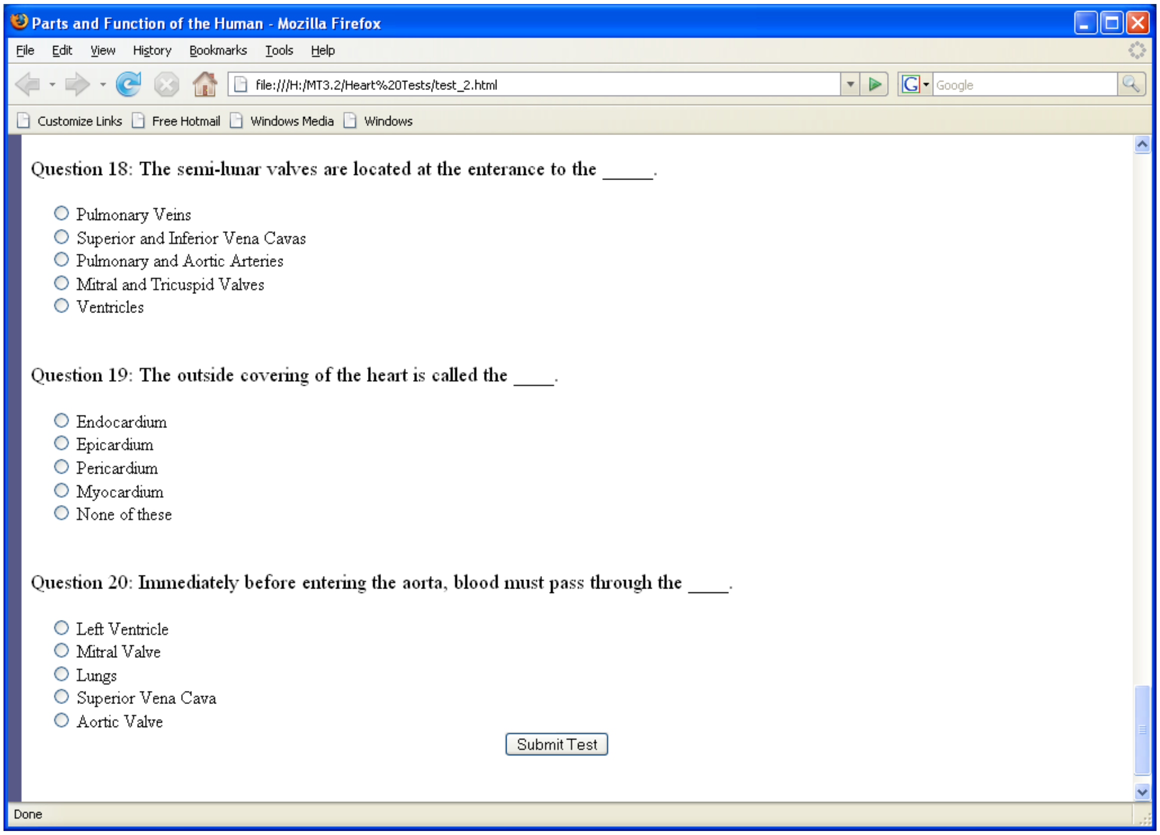
- Septum
- Valves
- Arteries
- Veins
- Tendons

Question 16: The ____ is the common opening between the right auricle and the right ventricle.

- Mitral Valve
- Tricuspid Valve
- Septic Valve
- Pulmonary Valve
- Aortic Valve

Question 17: The ____ is a triangular flapped valve between the left auricle and the left ventricle.

- Aortic Valve
- Pulmonary Valve
- Septic Valve
- Tricuspid Valve
- Mitral Valve



Parts and Function of the Human - Mozilla Firefox

Question 18: The semi-lunar valves are located at the enterance to the _____.

- Pulmonary Veins
- Superior and Inferior Vena Cavas
- Pulmonary and Aortic Arteries
- Mitral and Tricuspid Valves
- Ventricles

Question 19: The outside covering of the heart is called the ____.

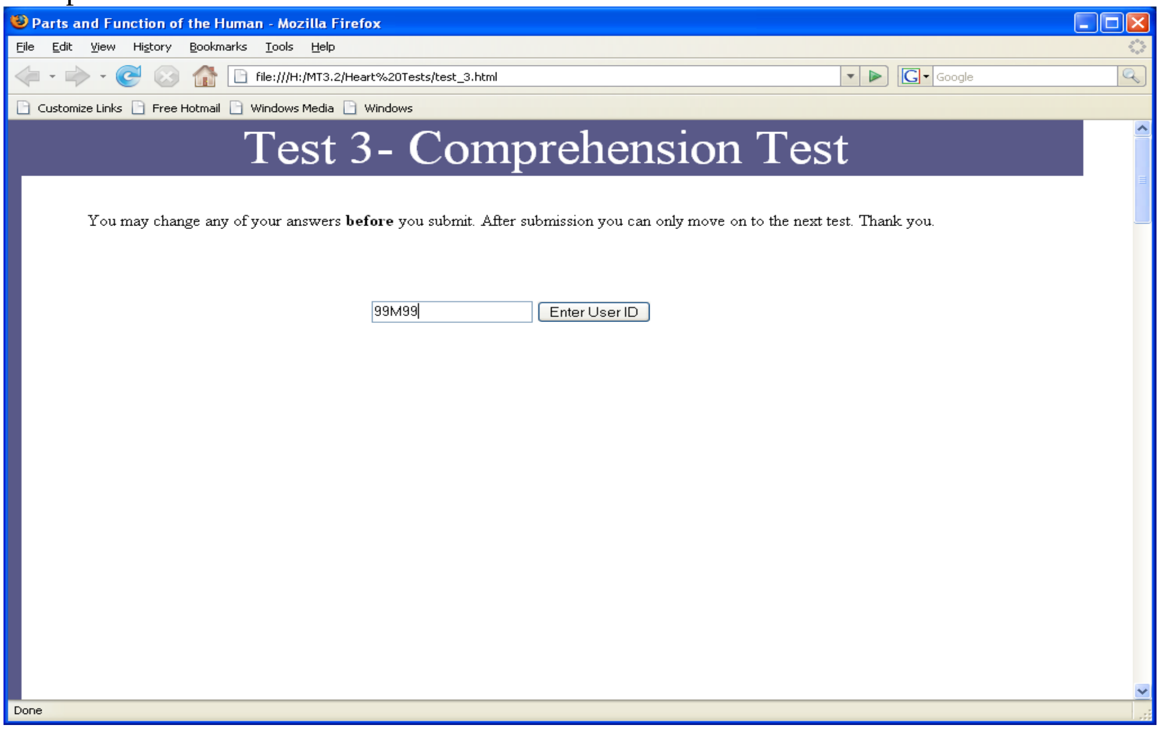
- Endocardium
- Epicardium
- Pericardium
- Myocardium
- None of these

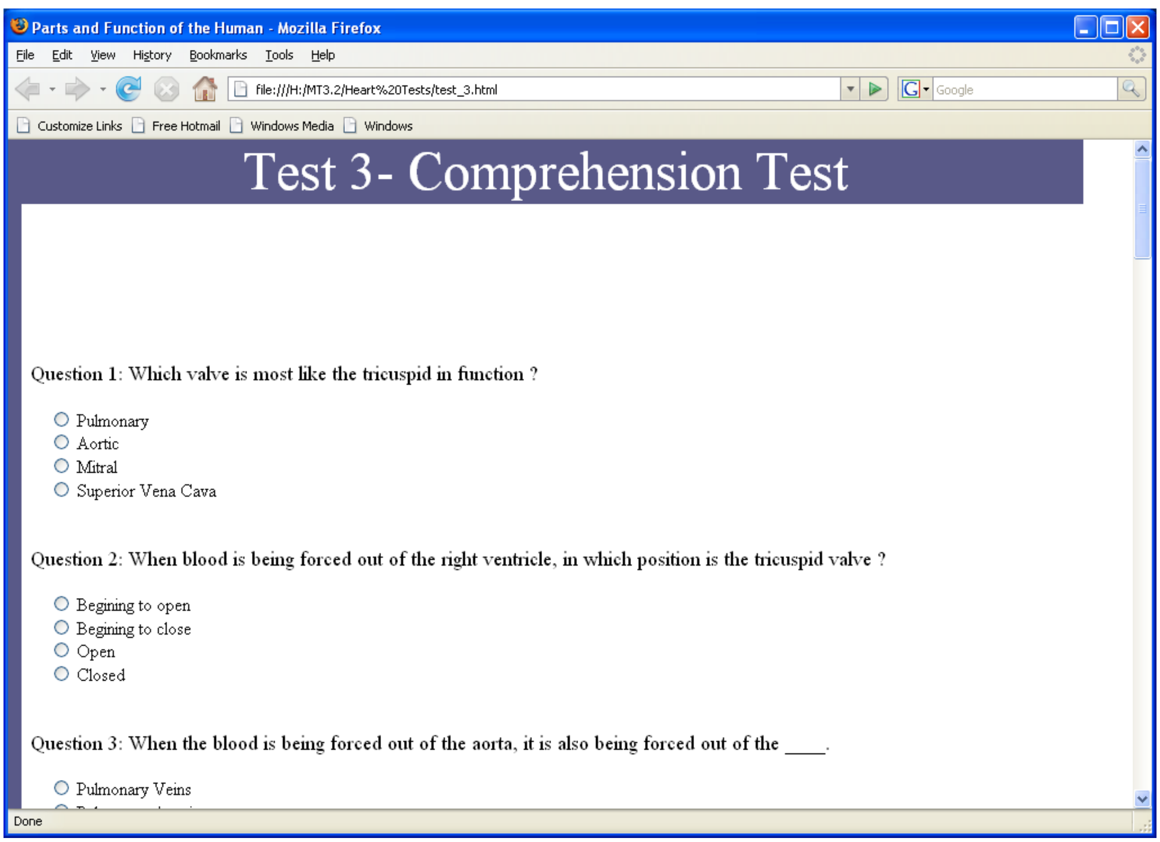
Question 20: Immediately before entering the aorta, blood must pass through the ____.

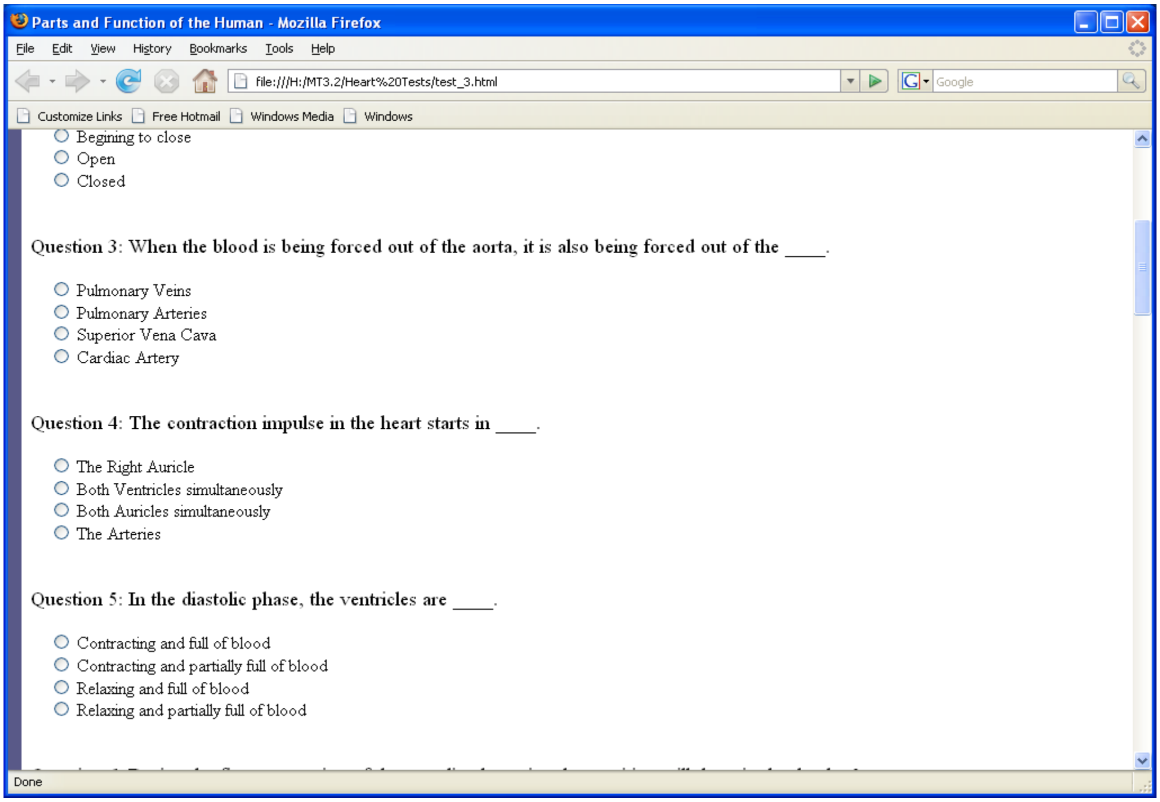
- Left Ventricle
- Mitral Valve
- Lungs
- Superior Vena Cava
- Aortic Valve

Submit Test

Comprehension Test







Parts and Function of the Human - Mozilla Firefox

- Begining to close
- Open
- Closed

Question 3: When the blood is being forced out of the aorta, it is also being forced out of the ____.

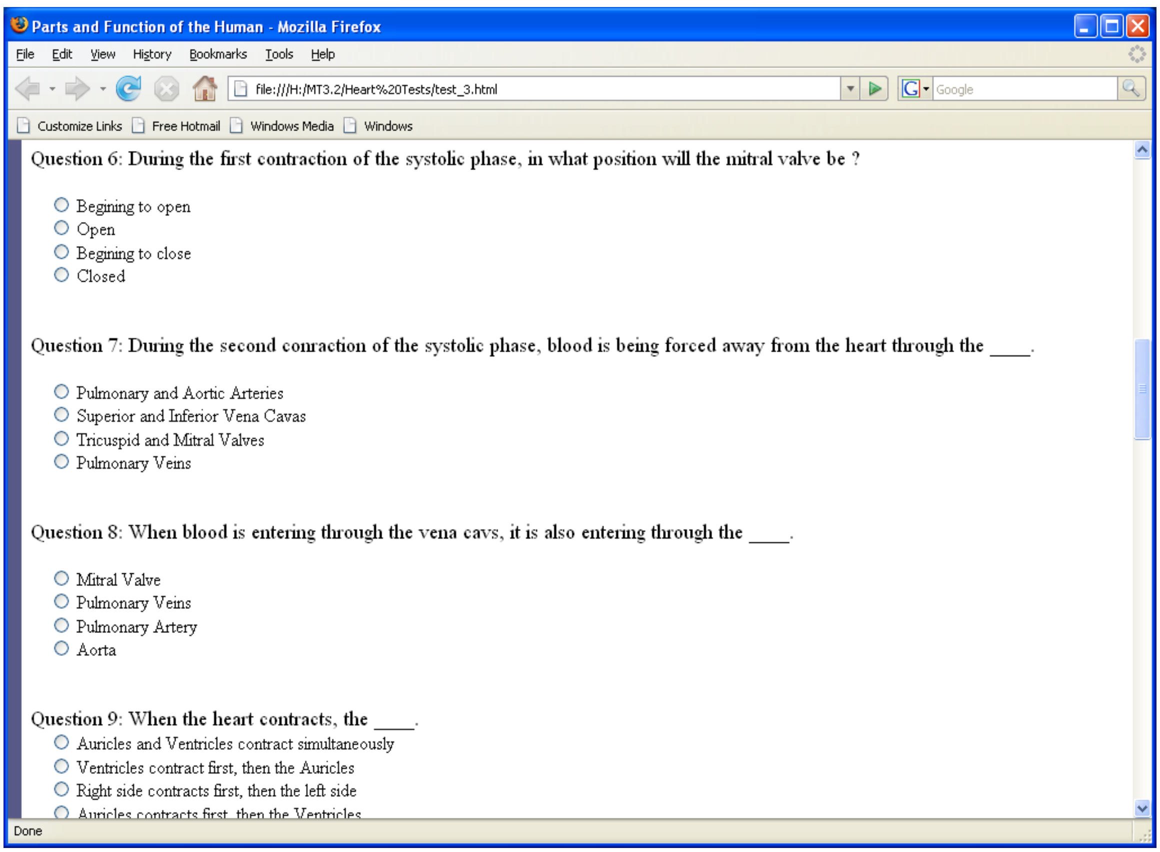
- Pulmonary Veins
- Pulmonary Arteries
- Superior Vena Cava
- Cardiac Artery

Question 4: The contraction impulse in the heart starts in ____.

- The Right Auricle
- Both Ventricles simultaneously
- Both Auricles simultaneously
- The Arteries

Question 5: In the diastolic phase, the ventricles are ____.

- Contracting and full of blood
- Contracting and partially full of blood
- Relaxing and full of blood
- Relaxing and partially full of blood



Parts and Function of the Human - Mozilla Firefox

Question 6: During the first contraction of the systolic phase, in what position will the mitral valve be ?

- Begining to open
- Open
- Begining to close
- Closed

Question 7: During the second conraction of the systolic phase, blood is being forced away from the heart through the ____.

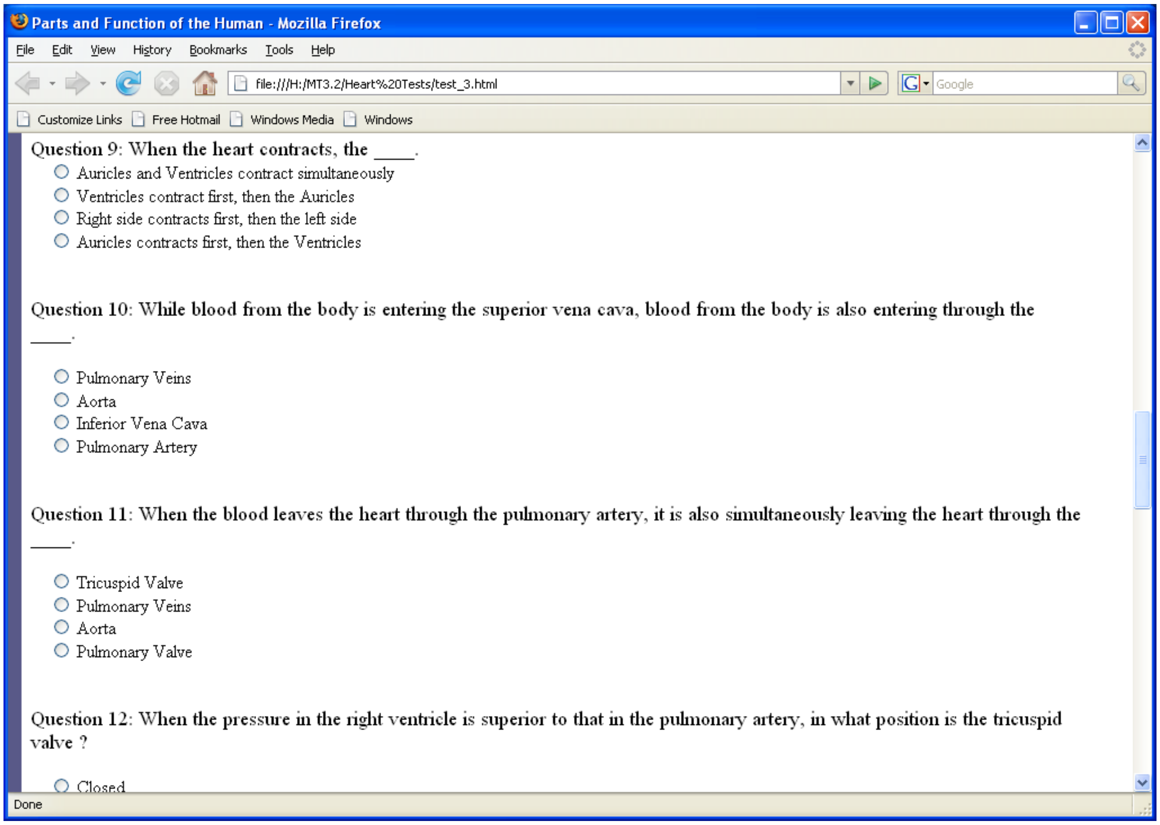
- Pulmonary and Aortic Arteries
- Superior and Inferior Vena Cavas
- Tricuspid and Mitral Valves
- Pulmonary Veins

Question 8: When blood is entering through the vena cavs, it is also entering through the ____.

- Mitral Valve
- Pulmonary Veins
- Pulmonary Artery
- Aorta

Question 9: When the heart contracts, the ____.

- Auricles and Ventricles contract simultaneously
- Ventricles contract first, then the Auricles
- Right side contracts first, then the left side
- Auricles contracts first, then the Ventricles



Question 9: When the heart contracts, the ____.

- Auricles and Ventricles contract simultaneously
- Ventricles contract first, then the Auricles
- Right side contracts first, then the left side
- Auricles contracts first, then the Ventricles

Question 10: While blood from the body is entering the superior vena cava, blood from the body is also entering through the ____.

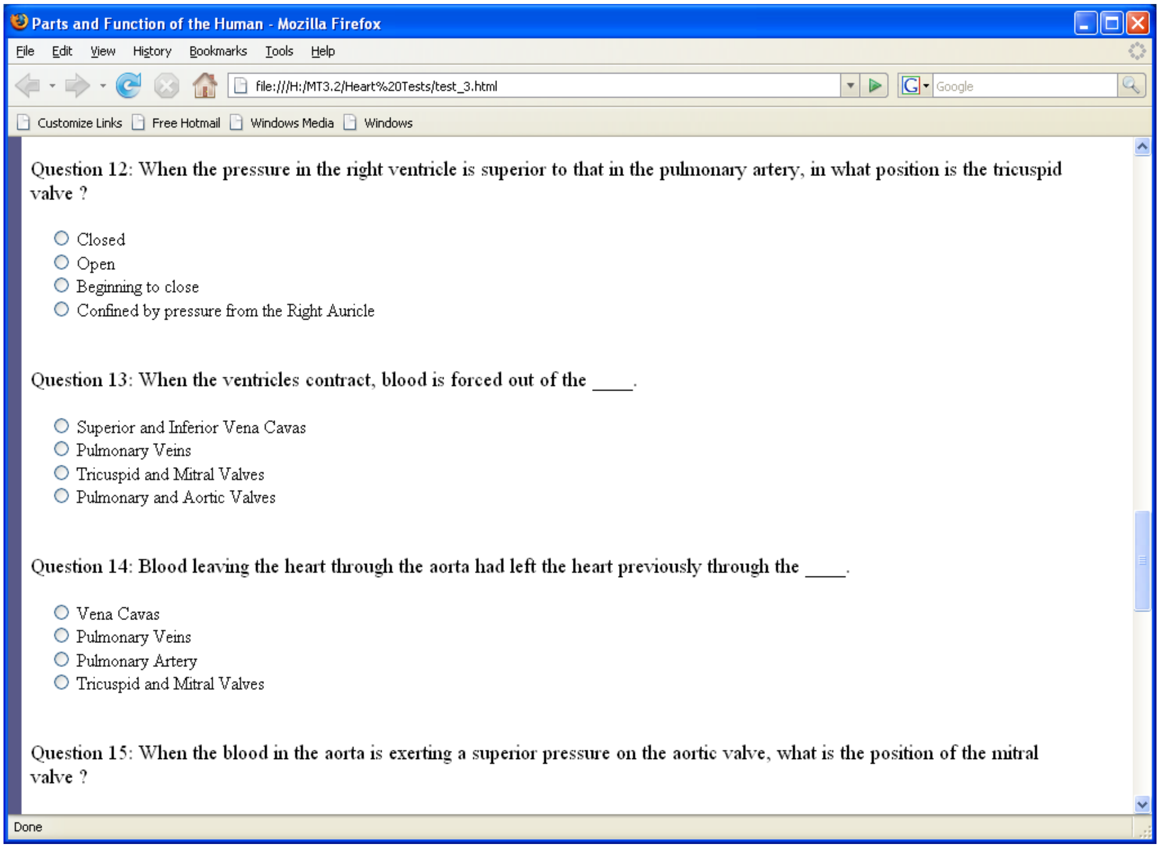
- Pulmonary Veins
- Aorta
- Inferior Vena Cava
- Pulmonary Artery

Question 11: When the blood leaves the heart through the pulmonary artery, it is also simultaneously leaving the heart through the ____.

- Tricuspid Valve
- Pulmonary Veins
- Aorta
- Pulmonary Valve

Question 12: When the pressure in the right ventricle is superior to that in the pulmonary artery, in what position is the tricuspid valve ?

- Closed



Question 12: When the pressure in the right ventricle is superior to that in the pulmonary artery, in what position is the tricuspid valve ?

- Closed
- Open
- Beginning to close
- Confined by pressure from the Right Auricle

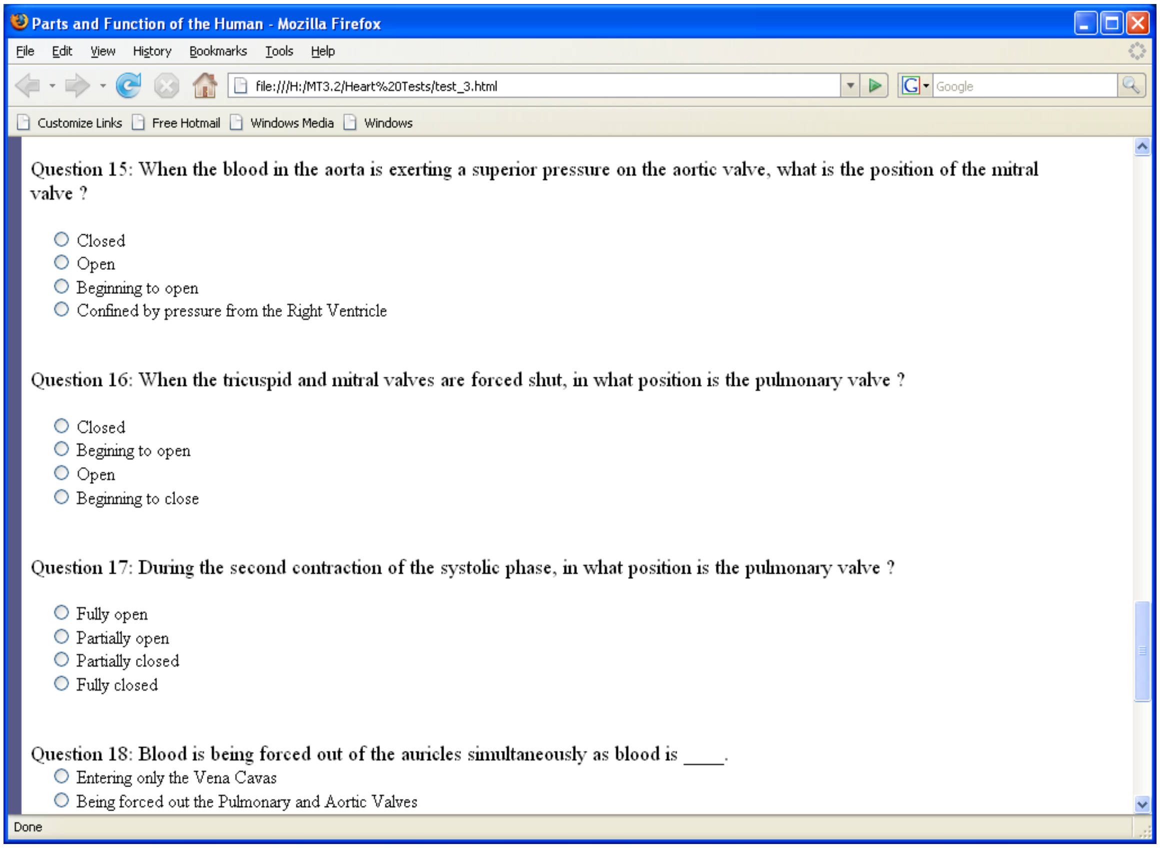
Question 13: When the ventricles contract, blood is forced out of the ____.

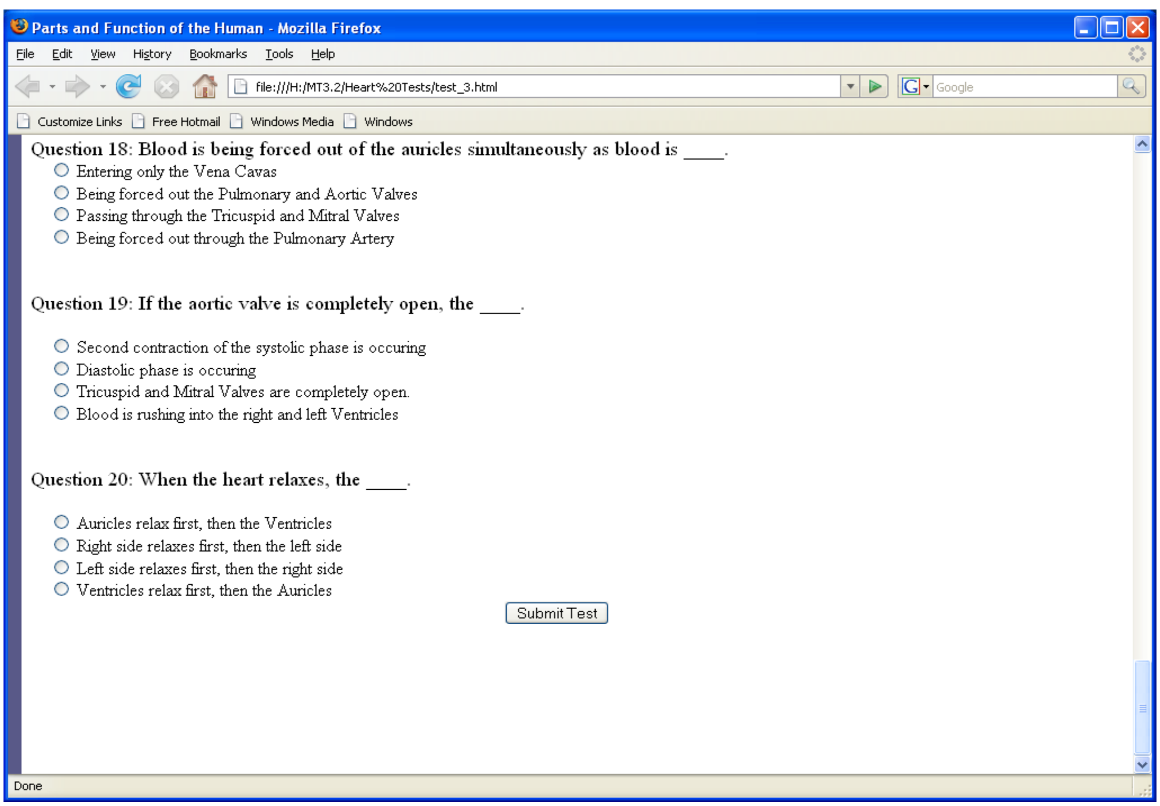
- Superior and Inferior Vena Cavas
- Pulmonary Veins
- Tricuspid and Mitral Valves
- Pulmonary and Aortic Valves

Question 14: Blood leaving the heart through the aorta had left the heart previously through the ____.

- Vena Cavas
- Pulmonary Veins
- Pulmonary Artery
- Tricuspid and Mitral Valves

Question 15: When the blood in the aorta is exerting a superior pressure on the aortic valve, what is the position of the mitral valve ?


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT3.2/Heart%20Tests/test_3.html
Google
Customize Links Free Hotmail Windows Media Windows
Question 15: When the blood in the aorta is exerting a superior pressure on the aortic valve, what is the position of the mitral valve ?
Closed
Open
Beginning to open
Confined by pressure from the Right Ventricle
Question 16: When the tricuspid and mitral valves are forced shut, in what position is the pulmonary valve ?
Closed
Begining to open
Open
Beginning to close
Question 17: During the second contraction of the systolic phase, in what position is the pulmonary valve ?
Fully open
Partially open
Partially closed
Fully closed
Question 18: Blood is being forced out of the auricles simultaneously as blood is ____.
Entering only the Vena Cavas
Being forced out the Pulmonary and Aortic Valves
Done


Parts and Function of the Human - Mozilla Firefox
File Edit View History Bookmarks Tools Help
file:///H:/MT3.2/Heart%20Tests/test_3.html
Google
Customize Links Free Hotmail Windows Media Windows
Question 18: Blood is being forced out of the auricles simultaneously as blood is ____.
Entering only the Vena Cavas
Being forced out the Pulmonary and Aortic Valves
Passing through the Tricuspid and Mitral Valves
Being forced out through the Pulmonary Artery
Question 19: If the aortic valve is completely open, the ____.
Second contraction of the systolic phase is occuring
Diastolic phase is occuring
Tricuspid and Mitral Valves are completely open.
Blood is rushing into the right and left Ventricles
Question 20: When the heart relaxes, the ____.
Auricles relax first, then the Ventricles
Right side relaxes first, then the left side
Left side relaxes first, then the right side
Ventricles relax first, then the Auricles
Submit Test
Done

Appendix F

Informed Consent Form for Social Science Research
The Pennsylvania State University

Title of Project: Effects of Varied Enhancement Strategies (Chunking, Feedback, Gaming) in Complementing Animated Instruction in Facilitating Higher Order Learning Objectives

Principal Investigator:	Mine Munyofu, Graduate Student 904 West Areba, Hershey PA 17033 Phone 717-533-7339 mxm939@psu.edu
Advisor:	Dr. Frank Dwyer, Advisor 310B Keller Building, University Park, PA 16802 (814)-863-7382 fmd@psu.edu
Other Investigator(s):	

1. **Purpose of the Study:** The purpose of this study is to investigate the instructional effectiveness of different levels of chunking (simple visual/text, and complex visual/text), different forms of feedback (item by item feedback, end of test feedback and no feedback), and use of instructional gaming in complementing animated programmed instruction on a test measuring different educational objectives.

2. **Procedures to be followed:** This study requires your participation in a computer lab. You will need to sign this consent form first. You will then interact with a web based instructional unit on the parts and functions of the human heart. You will then be asked to complete 3 post-tests to assess what you have learned.

3. **Duration:** About 2 hours

4. **Statement of Confidentiality:** Your participation in this research is confidential. You will not be identified by name or e-mail. However you will be given to a 5-character identifier that will be used to link all the tests you will take. There is no way to link test results with your identification.

5. **Right to Ask Questions:** You have the right to ask questions and have them answered. All questions should be directed to the researcher, Mine Munyofu, mxm939@psu.edu 717-533-7339.

6. **Payment for participation:** Participants will be entered in a drawing for one Xbox 360 and one of three Ipods after the completion of the study. The winner of the drawing needs to provide PSU ID number to the researcher to inform PSU accounting operations. Participant will also receive extra credits on their final course grade. If you do not choose to participate in this study you may earn extra credits by reading an article and summarizing one current article on a topic related to the course content identified by your instructor.

7. **Voluntary Participation:** Your participation is voluntary. You can stop at anytime. You do not have to answer any questions you do not want to answer.

You must be 18 years of age or older to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

You will be given a copy of this form for your records.

____ ____________________

Participant Signature Date

____ ____________________

Person Obtaining Consent Date

REFERENCES

Abney, S. (1991). Parsing by chunks. In R. Berwick, S. Abney, and C. Tenny, (Eds.), *Principle-based Parsing*. Dordrecht: Kluwer Academic Publishers.

Amory, A., Naicker, K., Vincent, J., & Adams, C. (1999). The use of computer games as an educational tool: identification of appropriate game types and game elements. *British Journal of Educational Technology*, 30(4), 311-321.

Bandura, A. (1977). *Social Learning Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bationo, B. D. (1992). The effect of three feedback forms on learning through a computer based tutorial. *CALICO journal*, 10(1), 45-52.

Bangert-Drowns, R. L., Kulik, C. C., Kulik, J. A., & Morgan, M. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research*, 61(2), 213–238.

Bower, M. (2005). Online Assessment feedback: Competitive, Individualistic or…Preferred Form. *The journal of Computers in Mathematics and Science Teaching*, 24(2), 121-127.

Buzhardt, J., & Semb, G. B.(2002). Item-by- item versus end of test feedback in computer based PSI course. *Journal of Behavioral Education*, 11(2), 89-104.

Carter, T., Hardy, C. A., & Hardy, J. C. (2001). Latin vocabulary acquisition: An experiment using information processing technique of chunking and imagery. *Journal of Instructional Psychology*, 28(4), 225-229.

Cameron, B.H. (2004). *The effect of gaming, cognitive style and feedback type in facilitating delayed achievement of different learning objectives*. Unpublished Doctoral Dissertation, Pennsylvania State University, University Park.

Cameron, B., & Dwyer, F. M. (2005). The effect of online gaming, cognition and feedback type in facilitating delayed achievement of different learning objectives. *Journal of Interactive Learning Research*, 16 (3), 243-258.

Chan, M., & Black, J. (2005) When can animation improve learning? Some implications on human computer interaction and learning. In P. Kommers & G. Richards (Eds.) *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2005* (AACE), (pp. 933-938). Chesapeake, VA.

ChanLin, L. (2000). Attributes of animation for learning scientific knowledge. *Journal of Instructional Psychology*, 27(4), 239–243.

Chase, W. G., & Simon, H. A. (1973). The mind's eye in chess. In W. G. Chase (Ed.), *Visual Information Processing*. New York: Academic Press.

Clariana, R.B., Wagner, D., Roher-Murphy, L.C. (2000). Applying connectionist description of feedback timing. *Educational Technology, Research and Development*, 48(3), 5-22.

Clark, J. M., & Paivio, A. (1991). Dual Coding Theory and Education. *Educational Psychology Review*, 3(3), 149-210.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology*, 4(1), 55-81.

Chen, P., & McGrath, D. (2003). Moment of Joy: Students engagement and conceptual learning in the design of hypermedia document. *Journal of Research and Technology*, 35(3), 402-423.

Cooper, G. (1998). Research into Cognitive Load Theory and Instructional Design at UNSW. Retrieved on Nov 11,2003 from http://education.arts.unsw.edu.au/CLT_NET_Aug_97.HTML

Cowan, N. (2001) The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, 24(1), 87-114.

Dempsey, J.V., Driscoll, M.P., & Litchfield, B.C. (1993). Feedback, retention, discrimination error, and feedback study time. *Journal of Research on Computing in Education*, 25(2), 303-326.

Dempsey, J. V., Lucassen, B., & Rasmussen, K. (1996). The instructional gaming literature: Implications and 99 sources (Technical Report 96-1). College of Education, University of South Alabama.

Dempsey, J. V., Lucassen, B. A., Haynes, L. L., & Casey, M. S. (1996). *Instructional Application of Computer Games.* Paper presented at the 1996 American Educational Research Association, New York.

Dwyer, F. M. (1978). *Strategies for improving visual learning*. State College, PA: Learning Services.

Dwyer, C.A., & Dwyer, F. M. (1985). The effect of visualized instruction and varied rehearsal and evaluation strategies (verbal and visual) in facilitating students' long-term retention on test measuring different educational objectives. *Journal of Visual languaging*, 5(2), 15-27.

Dwyer, F. M. (1990). A proposal preparation primer: A programmed approach. *Department of Adult Education and Instructional Systems*. University Park, The Pennsylvania State University.

Dwyer, F. (1994). One dimension of visual research: A paradigm and its implementation. In D. M. Moore & F. M. Dwyer (Eds.), Visual literacy: A spectrum of visual learning (pp. 383-401). Englewood Cliffs, N J: Educational Technology Publication.

Dwyer, F, M., & Dwyer, C. (2003*). Effect of Static of Animated Visualization in Facilitating Knowledge Acquisition*. State College, PA: The Pennsylvania State University.

Ellis, J.A., & Semp, G. B. (1998). Very long-term memory for information learned in an introductory college course. *Contemporary Educational Psychology*, 17, 243-261.

Feigenbaum, E. A., & Simon, H. A. (1984). EPAM-like models of recognition and learning. *Cognitive Science*, 8, 305-336.

Field, A. (2005). Discovering statistics using SPSS. (2nd ed.). London: Sage Publications.

Gagne, R. M., & Medsker, K.L. (1996). *The Conditions of Learning: Training Applications*. Fort Worth, TX: Harcourt Brace.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, Motivation, and Learning: A Research and Practice Model. *Simulation & Gaming*, 33(4), 441-467.

Gee, J.P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave Macmillan.

Gobet, F. (1998a). Expert memory: a comparison of four theories. *Cognition*, 66(2), 115-152.

Gobet, F., & Simon, H. A. (1996). Templates in chess memory: A mechanism for recalling several boards. *Cognitive Psychology*, 31(1), 1-40.

Gobet, F. (1998b). Memory for the meaningless: How chunks help. *Proceedings of the Twentieth Meeting of the Cognitive Science Society*, (pp. 398-403). Mahwah, NJ: Erlbaum.

Gobet, F., & Simon, H. A. (1998a). Expert chess memory: Revisiting the chunking hypothesis. *Memory*, 6 (3), 225-255.

Gobet, F., & Simon, H. A.(1998b). Pattern recognition makes search possible: Comments on holding(1992). *Psychological Research*, 61(3), 204-208.

Gobet, F., & Simon, H. A. (2000). Five seconds or sixty? Presentation time in expert memory. *Cognitive Science*, 24, 651-682.

Harrelson, G. L., & Leaver-Dunn, D. (2003). Four tips to manage cognitive overload. *Athletic Therapy Today*, 8(1), 47-49.

Huang, Z., & Cappel, J.(2005). Assessment of a web-based learning game in an information.systems course. *Journal of Computer Information Systems,* 45(4), 42-49.

Hunt, R.R., & Ellis, H.C. (1999). Fundamentals of Cognitive Psychology (6th Ed.). McGraw-Hill Companies.

Huk, T., Steinke, M., & Floto, C. (2003). Computer animations as learning objects: what is an efficient instructional design, and for whom? Proceedings of IADIS WWW/Internet 2003, Algarve, Portugal.

Keyes, E., & Krull, R. (1992). User Information Processing Strategies and Online Visual Structure. *In ACM Tenth International Conference on System Documentation 1992* (pp. 121-128). Ottawa, Canada.

Kulhavy, R. W., & Stock, W. A. (1989). Feedback in written instruction: The place of response certitude. *Educational Psychology Review*, 1(4), 279-308.

Kulik, J. A., & Kulik, C. C. (1988). Timing of feedback and verbal learning. *Review of Educational Research*, 58(1), 79-97.

Lane, P. C. R., Gobet, F., & Cheng, P. C-H. (2000). What forms the chunks in a subject performance? Lessons from CHREST Computational Model of Learning. *Behavioural and Brain Sciences*, 24, 128-129.

Lohr, L., Roberts, S., & Gall. J. (2003). The promise of memory research for instructional visual design. *Proceedings of the 2003 International Visual Literacy Conference*, Newport, RI.

Lin, H., Kidwai, K., Munyofu, M., Swain, W. J., Ausman, B., & Dwyer, F. (2005). Effect of verbal advance organizers in complementing animated instruction. *Journal of Visual Literacy*, 25(2), 237-248.

Lowe, R.K. (2004). Animation and learning: Value for money? In R. Atkinson, C. McBeath, D. Jonas-Dwyer & R. Phillips (Eds), *Beyond the comfort zone: Proceedings of the 21st ASCILITE Conference* (pp. 558-561). Perth, Australia.

Mason, B.J., & Bruning, R. (2001) *Providing feedback in computer-based instruction: What the research tells us.* Retrieved on April 12, 2004, from http://dwb.unl.edu/Edit/MB/MasonBruning.html

McEacharn, M.(2005). Game play in the learning Environments: Who wants to be an Accountant? Lawyer? Economist? *Accounting Education: An international journal*, 14(1), 95-101.

Miller, A. G (1956). The Magical Number Seven, Plus or Minus Two: Some limits on Our Capacity for Processing Information. *Psychological Review*, 63, 81-97.

Molnar, A. (1997). Computers in education: A brief history. *T. H. E Journal,* 24(11), 63-69.

Moreno, R., & Valdez, A. (2005). Cognitive load and Learning effects of having students organize pictures and words in multimedia environments: The role of student interactivity and feedback. *Educational Technology Research and Development*, 53(3), 35-45.

Munyofu, M., Swain, W.J., Ausman, B. D., Lin, H., Kidwai, K., & Dwyer, F. (2007). Effect of different chunking strategies in complementing animated instruction. *Learning, Media and Technology*, 32(4), 407-419.

Narciss, S., & Huth, K. (2002). How to design informative tutoring feedback for multi media learning. *Instructional design for multimedia learning*. In: Niegemann, H.M., Leutner, D., Brünken, R. (Eds.), *Instructional design for multimedia learning* (pp. 181-195). Waxmann, Münster.

Nash, A.N., Muczyk, J.P., & Vettori, F. L.(1971). The Relative Practical Effectiveness of Programmed Instruction. *Personnel Psychology*, 24(3), 397-418.

Nitko, A. J. (2001). *Educational assessment of students*. Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Newell, A., & Simon, H.A., (1972). *Human Problem Solving*. Prentice Hall, Englewood Cliffs, NJ.

Paivio, A. (1971). *Imagery and Verbal Processes*. New York: Holt, Rinehart, and Winston.

Paivio, A. (1986). *Mental Representations: A dual-coding approach*. New York: Oxford University Press.

Park, O., & Gittelman, S. S. (1992). Selective use of animation and feedback in computer-based instruction. *Educational Technology Research & Development*, 40 (4), 27-38.

Pashler, H., Cepeda, N. J., Wixted, J. T., & Rohrer, D. (2005). When does feedback facilitate learning of words. *Journal of Experimental Psychology*, 31(1), 3-8.

Plate, T.A. (2000). Analogy retrieval and processing with distributed vector representation. *Expert Systems:The International Journal of Knowledge Engineering and Neural Networks*, Special Issue on Connectionist Symbol Processing, 17(1), 29-40.

Petterson, R. (1989). *Visuals for Information: Research and Practice*. Englewood Cliffs, NJ: Educational Technology Publications.

Reiber, L. P. (1990). Animation in computer based instruction. *Educational Technology Research and Development*, 38(1), 77-86.

Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research & Development*, 44(2), 43-58.

Sandford, R., & Williamson, B. (2005). *Games and Learning: A handbook from Futurelab*. Bristol: Futurelab. Retrived on September 2007 Retrieved from http://www.futurelab.org.uk/handbooks/03_01.htm

Semb, G. B., & Ellis J.A. (1994). Knowledge taught in school: what is remembered? *Review of Educational Research*, 64(2), 253-286.

Simon, H.A. (1974). How big is a chunk? *Science*, 183(4124), 482-488.

Simpson , E. S. (2005). What teachers need to know about the video game generation. *TechTrends*, 49(5), 17-22.

Skinner, B. F. (1950). Are Theories of Learning Necessary. The Psychological Review, 57(4), 193-216.

Squire, K.D. (2005). Guest Editor's Note. *TechTrends*, 49(5), 3.

Squire, K. D., Giovanetto, L., Devane, B., & Durga, S.(2005). From user to designer: Building a self-organizing game-based learning environment. *TechTrends*, 49(5), 34-43.

Sweller , J. (2004). Instructional design consequences of an analogy between exolution by natural selection and human cognitive architecture. *Instructional Science*, 32(1), 9-31.

Tabachnick, B. G., & Fidel, L. S. (2001). *Using multivariate statistics* (4th ed.). Needham, MA: Allyn and Bacon.

Tversky, B., Bauer-Morrison, J., & Betrancourt, M. (2002) Animation: Can it facilitate? *International Journal of Human-Computer Studies*, 57, 247-262.

Van Merrienboer, J. J. G., & Ayres, P.(2005). Research on cognitive load theory and its design implications for E-learning. *Educational Technology Research and Development*, 53(3), 5-13.

Vanevery, H., & Rosenberg, S. (1970). Semantics, Phrase, Structure, and Age as Variable in Sentence Recall. *Child Development*, 41(3), 853-859.

Whelan, D. L. (2005). Let the games begin! *School library Journal*, 51(4), 40-45.

Zamel, V. (1981). Cybernetics: A model for feedback in the ESL classroom. *TESOL Quarterly*, 15(2), 139-150.

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Lin, H., Kidwai, K., Munyofu, M., Swain, W. J., Ausman, B., Dwyer, F. (2005). Effect of verbal advance organizers in complementing animated instruction. *Journal of Visual Literacy*, 25(2), 237-248.

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