

VIRGINIA VETERINARY SCIENCE CURRICULUM RESOURCES

SHERRY ANN EASTEP HEISHMAN

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in  
partial fulfillment of the requirements for the degree of

Master of Science  
In  
Agricultural Life Sciences

Megan Seibel Committee Chair  
James C. Anderson  
John Hillison

December 2015  
Blacksburg, Virginia

## ABSTRACT

A historical look at agriculture education curricula allows us to move forward to provide teaching tools and strategies for our students to experience greater academic achievement while also encouraging them to expand their 21st century skillset. In many classrooms, teachers are looking to find teaching resources and tools for veterinary science; they are looking for ways to increase student engagement. More specifically, teachers are looking for resources to help students develop the competencies to make them globally competitive in the job market. History has shown that students are not reaching their full potential and experience relatively high levels of anxiety and frustration, which negatively impacts learning. The global market for the agriculture industry has drastically changed since 1917 and so should the curricula and education options offered to students. Providing multiple hands-on and problem-solving learning opportunities as the foundation of agricultural education has allowed, coupled with engagement and contemporary strategies such as STEM and critical thinking activities, an increase in student engagement. The teaching tools provided by this project encourage hands-on educational experiences related to real world experiences. To assess the curriculum, teachers and administrators reviewed, assessed, and provided feedback on the resources and activities. Overwhelmingly, respondents stated that the activities were well thought-out, would be beneficial for increasing students' learning, and provided problem-solving learning opportunities for students. Further respondents indicated that the activities could easily be incorporated into lesson plans. Additionally, the teaching tools were aligned with Virginia Department of Education competencies and Standards of Learning. Further curriculum should be developed to allow all Virginia students to benefit.

*Keywords:* veterinary science, 21<sup>st</sup> century skills, experiential learning, critical thinking

## Table of Contents

Abstract.....	ii
Table of Contents.....	iii-v
Chapter One Introduction.....	1
Background and Setting.....	1
Historical Background.....	1-3
Curricula Shift.....	3-5
Instructional Strategies.....	5-8
Figure 1.....	6
Statement of the Problem.....	8
Purpose.....	8
Objectives.....	9
Definitions of Terms.....	9-10
Limitations.....	10-11
Significance of the Problem.....	11
Chapter Two Review of Literature.....	12
Historical Background.....	12-14
Virginia Statistics.....	14-15
Teaching Strategies.....	16-17
Learning Aids.....	17
Experiential Learning.....	18
Figure 2 .....	19
Problem-Based Learning.....	19-20

STEM.....	20
Workforce.....	21-22
Critical Thinking.....	22-23
Theoretical Framework.....	23-24
Summary of Chapter.....	24-25
Chapter Three Methodology.....	26
Methodology.....	26-27
Data Collection.....	28-29
Chapter Four Project Outcome and Discussion .....	30
Findings .....	30-45
Reflection.....	46
Chapter Five Conclusion and Recommendations.....	47
Conclusion.....	47
Recommendations Based of Study.....	48-49
References.....	50-55
Appendices.....	56
Virginia Department of Education Competency and Task list.....	56
Appendix A Cruisin' with the Heart an Evaluation Rubric.....	57-59
Appendix B Worksheet Circulatory System, Key and PowerPoint.....	60-68
Appendix C Observing Circulatory System in Fish Lab.....	69-70
Appendix D Edible Blood Lab.....	71-72
Appendix E Raising the Beat Lab.....	73-76
Appendix F Worksheet Blood Flow.....	77-78

Appendix G Daphnia Heart Function Inquiry.....	79-80
Appendix H Sheep Heart Dissection.....	81-89
Appendix I Urinalysis Lab.....	90-93
Appendix J Coloring Kidney Worksheet.....	94-101
Appendix K Pig Kidney Dissection.....	102-104
Appendix L Kidney Filtration Lab.....	105-114
Appendix M Evaluation Form.....	115

## **Chapter I**

### **Introduction**

#### **Background and Setting**

In agricultural classrooms all over the United States, including Virginia, teachers are looking for resources to help engage students in learning. As Winston Churchill said, “The farther backward you look the farther forward you are likely to see” (Goodreads, 2015). This project will look back at a bit of agriculture curriculum history and look forward to the needs of our students. By using and connecting history, the goal is to develop instructional tools that will help future teachers and students in the agricultural education course of veterinary science. This project will examine various teaching strategies that will aid both teachers and students in accomplishing the goal of learning the specific competencies and tasks required by the Virginia Department of Education.

Reevaluating and updating curricula is not new to agricultural education or its teachers. The role of the agricultural teacher has a rich history and a wide-open future in developing curriculum. The agricultural industry changes rapidly every day and teachers must keep up with those changes to better prepare students for careers and opportunities. Since the days of the 1917 Smith-Hughes Act, the needs of agricultural education, along with its mission, have changed. Thus, it is essential for curriculum changes to better equip students for opportunities in the workforce. Agricultural education teachers need resources to prepare students for opportunities in specialized fields such as veterinary science.

#### **Historical Background**

Agricultural education has developed and transformed since the founding of the United States. Many significant events have helped agricultural education evolve. Benjamin Franklin

advocated the teaching of agriculture in every town as early as 1749 (Shelly-Tolbert, Conroy, & Dailey, 2000). Moving forward through the land-grant years of the 1800s (1862-1890), on to February 23, 1917, agricultural education received federal support when President Woodrow Wilson signed the Smith-Hughes Act, which provided federal recognition for vocational education. The Smith-Hughes Act specified vocational programs, created administrative procedures, and prescribed skills-based training programs for instruction in agriculture, trade and industries, and home economics (“Smith-Hughes Act,” 2015). Under the Smith-Hughes plan of vocational instruction, the student was to learn the practice of agriculture through first-hand experience and focused more on the farm boy and teaching him specific skills to make an honest living. The Vocational Education Act of 1963 authorized federal funds to support residential vocational schools, vocational work-study programs, research, training, and demonstrations in vocational education, business education, and permitted off-farm instruction. At this point in vocational agriculture, four courses with names of Vocational Agriculture 1, 2, 3, and 4 were offered for students to learn. (J. Hillison, personal communication, September 9, 2015). Jumping forward to 1976, the Vocational Education Act aimed at improving student achievement in reading, mathematics, and written and oral communication. Vocational Agriculture reached the pinnacle of its enrollment in 1976 and 1977 (C. Woolfolk personal communication, August 28, 2015). A few short years later, leading into the 1980s, a steady decline in enrollment occurred all over the country.

As a result of the decline, a study was started in 1985. That study, *Understanding Agriculture: New Direction in Education* (1988) was initiated because of decline in profitability and international competitiveness of American agriculture, instructional content and quality in agricultural education programs. At the time, with less than three percent of the population

engaged in farming, there was enormous need for agricultural education teachers to change their focus. The study focused on agricultural literacy and curricula change. At that time 40.6% of vocational agriculture departments were strictly production-oriented; thus, vocational agriculture was preparing students for a shrinking job market. The study recognized that vocational agriculture curricula had failed to keep up with modern agriculture. Vocational agriculture's production emphasis of the first half-century was no longer as relevant. Further recognizing the program needed more flexibility in curriculum and program design coupled with the requirements and FFA activities. For agricultural departments across the country, the study suggested that courses taught should deemphasize production agriculture while increasing instruction in agribusiness and emerging technologies in agriculture.

As a consequence of history and of these various acts and studies, agricultural education has changed its curriculum needs, focus, and mission. In the early days, agricultural education prepared pupils to enter the workforce by training for specific jobs. As growth and technology have evolved within the industry the need for a more diverse curriculum has come into play. In recent decades, agricultural education has been updating the curriculum to emphasize science and integrating academics with agricultural education in part as a result from the Carl D. Perkins Act and National Skills Standards of the 1990s. This paradigm shift is called agriscience.

### **Curricula Shift**

The curricula shift to the integration of scientific principles into agriculture is forcing current agricultural education programs to alter the curricula and change teaching and thinking. Teaching scientific principles through the use of agriculture will enable students to apply the scientific knowledge gained and provide more areas within agriculture that students can pursue. There are many ways to incorporate science through agriculture. What better way to capture

student interest in science than through real-world examples and hands-on experiences through agricultural education? Students need opportunities and teachers should have the tools necessary to provide those experiences as suggested in previous legislative moves. Just as the curricula have shifted so has the role of the agricultural teacher. That role has changed from teaching farm boys the art and science of production agriculture and has shifted to one that requires the teacher to be a facilitator of learning that include technology and innovation to help students become critical thinkers, researchers and 21<sup>st</sup> century learners that they are best suited for careers available to them as well as those careers not yet developed.

A needs assessment survey compiled by the Virginia Association of Agricultural Educators in 2013 showed one area of need among Virginia Agriculture Teachers was workshops to facilitate hands-on learning and, more specifically, for the veterinary science course (B. Fisher, personal communication, September 19, 2015). In just the last two years, this researcher has conducted five workshops to help over 30 teachers find and use resources to enhance the Veterinary Science course. There were 107 responses to the survey question: Please list the five most important programs or curricula that you offer in your program. Twenty-six responses to the question revolved around veterinary science. In the survey teachers were also asked to respond to the following question: Please list the five specific programmatic areas you would like to see available in terms of professional development (e.g., greenhouse management, plant systems, forestry, etc.). Of the 87 responses provided by agricultural teachers across the state 28 responded veterinary science.

Additionally, on the survey, teachers were able to provide open comments on their needs as professionals. Comments from the survey included and are not limited to, “On the classroom side of professional development, I would love to see opportunities geared toward developing actual

activities or sharing of activities that are done throughout classroom across the state. So often we receive professional development on certain learning techniques or instructional strategies but I always leave these experiences without tangible activities or ideas for teaching material and assessing learning in an interesting way;” “As a new teacher it is difficult to come up with interesting idea out of thin air and some of my best and most interesting lessons have been developed through sharing ideas and talking to other people about their ideas and activities;” “Learning new strategies, providing materials for teachers, for engaging students and keeping interest,” “Activities that relate to content but are easy to do (not budget-limiting) and that students find relevant,” “The VDOE has nothing to offer me as far as guidance besides the Verso site.”

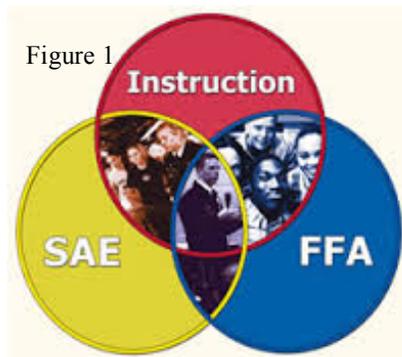
Although Virginia has offered a Veterinary Science Class since 2004 and has a set of competencies and tasks that students should learn, as the VAAE survey attests, Virginia teachers do not have curriculum resources to help implement these tasks in their classes (C. Woolfolk, personal communication, August 28, 2015). A solution to this lies in developing more hands-on, in-depth activities and practicums to enhance the existing curriculum. Adding these teaching tools will provide students with beneficial skills that will stay with them for a lifetime. Teaching students to be critical thinkers and lifelong learners is a goal for teachers.

### **Instructional Strategies**

Learning is not an event but a process. Learning is the continual growth and change in the brain. These changes result from the many ways we take in information, process, connect, catalogue, use and even delete some of the information. Learning is generally categorized into three domains: cognitive, affective, and psychomotor (Anderson, 2001). Of the specific domains cognitive, Benjamin Bloom’s Taxonomy, is how we acquire, process, and use knowledge. It

could be considered the thinking domain. Affective domain, David Krathwohl's Taxonomy, deals with our attitudes, values, and emotions. This domain can be considered the valuing domain. The psychomotor domain, Anita Harrow's Taxonomy, deals with manual or physical skills and can be considered the doing domain (Anderson, 2001). Within each domain there are multiple levels of learning that progress from more basic to more complex, deeper-level learning. The level of learning impact will vary across learning experience. This depends on the nature of the experience, the developmental levels of the students, and the duration and intensity of the experience. These three domains fit well into in Agricultural Education's three-circle model.

Agricultural Education was established on the three-circle model, as shown in Figure



National FFA, 2015

1(National FFA, 2015) to the left, that includes classroom/laboratory instruction, Supervised Agricultural Experience (SAE), and FFA (formerly Future Farmers of America). Agricultural education allows students to learn about agricultural practices in the classroom and then apply those practices to their supervised agricultural experience (SAE) and FFA (Georgia Agricultural Education, 2011). Through this type of learning, students gain hands-on experience in the industry and are able to learn more about agriculture. The students in agricultural classes are thought to be “. . . the change-makers in our society” (Tesch, 2006, p. 93). Agricultural Education and FFA strategy includes learning by doing.

One teaching strategy in the foundation of agricultural education is Problem Based Learning (PBL)(Problem Based Learning, 2014). PBL is an effective and enjoyable way to learn and develop deeper learning competencies required for success in college, career and civic life

(Problem Based Learning, 2014). A study conducted by B.A. Talbert, Ph.D. in 2004 concluded that FFA members who were more involved and participating in agriculture classes did so because the classes were interesting, challenging, exciting, and open for discussion (Talbert, 2004).

Common Core State Standard's (CCSS) mission statement suggests CCSS are designed to reflect real-world knowledge and skills necessary for student success in college and careers. Today's science standards require real- world scenarios and questions that force students to be able to apply their learning (Common Core State Standards Initiative, 2014). The United States Department of Education has implemented programs to meet the growing demand of students to be prepared to enter professions with real-world experience. Science, Technology, Engineering and Mathematics, also referred to as STEM, focuses on developing standards in leadership while educating students in those corresponding subject areas. President Barack Obama stated that “. . . Leadership tomorrow depends on how we educate our students today- especially in science, technology engineering and math” (Ed.gov, 2010, para.1).

Furthermore, teachers will need to move from teacher-centered philosophy to the student-centered learning philosophy. One contemporary teaching strategy for getting students engaged and learning is through STEM. STEM focuses on preparing youth with invaluable experiences in educational fields where the demand for these professions are not being met. The veterinary science field is one scientific area where higher standards must be met. According to Texas A&M, one of the oldest and most prestigious veterinary science programs in the United States, “Becoming a veterinarian requires dedication and diligent study. The veterinary medical student must meet high standards of ethics and academic performance ” (Texas A&M University, 2013,para.1). Virginia Agricultural Education Programs provide veterinary science instruction in

39 high schools reaching over 675 students per year (C. Woolfolk, personal communication, August 28, 2015). Providing these kinds of learning experiences can help our students excel as 21<sup>st</sup>-century learners and acquiring 21<sup>st</sup>-century workforce readiness skills.

### **Statement of the Problem**

A Strategic Review of Agricultural Education 2013 by the VDOE encouraged STEM programs through agricultural education, implement blended agricultural academic course that engage students in rigorous and relevant problem-based experiences and inquiry-based science. Additionally, the needs assessment for Virginia Agriculture Educators indicated that teachers have the competencies and task list but no resources and teaching aids to implement them. What types of resources can be developed to help teachers in the veterinary science course?

### **Purpose**

The purpose of this project will be to provide teaching tools such as practicums, worksheets, and activities for teachers to be used in the Veterinary Science Course. Incorporation of these tools will allow components of the three-circle model to overlap, creating a culminating experience for students. Students will be taught veterinary science competencies in their classroom/laboratory component, and can thus master skills and be more prepared for their potential SAE projects or obtain employment coupled with the ability to compete in FFA Career Development Events. More specifically, this project will include practicums, labs, and resources, chosen on request given to the researcher from teachers, for the Virginia Department of Education Course 8088 Veterinary Science unit Anatomy and Physiology specifically for competencies:

- #67 Explain the anatomy and physiology of the circulatory system
- #68 Explain the Anatomy and physiology of the urinary system

### **Objectives**

1. To develop curriculum resources and teaching tools such as labs, worksheets, practicums, and activities for extensions to the veterinary science curriculum competencies.
2. To prepare and implement sample activities for use in the veterinary science course that meet the Virginia Department of Education State Competencies.
3. To evaluate the educational effectiveness of the curriculum by receiving feedback from education professionals of veterinary science courses.

### **Definition of Terms**

- Agricultural literacy: possessing knowledge and understanding of the food and fiber system and agriculture industry (Merriam-Webster, n.d.).
- Alternative Assessments: interactive ways, other than standardized or conventional tests, for teachers to determine what students have learned and areas in which they need assistance; examples include oral presentations, projects, and experiments (Stears & Gopal, 2010).
- Career Development Events (CDE): provided through FFA contests, they prepare members, especially participants for more than three hundred careers in the agriculture industry by challenging them with real-life, hands-on tests of useful skills (National FFA Organization Statistics, 2015).
- Competency: an ability or skill (Merriam-Webster, n.d.).
- Critical Thinking: an active process in which the thinker considers alternatives, combines ideas, takes risks to find new connections, and evaluates steps to a conclusion (Dixon, 2004, p. 57)

- Curriculum: a set of courses constituting an area of specialization offered at an educational institution (Merriam-Webster, n.d.).
- Engagement: a state in which students are actively participating in order to learn new ideas, concepts, and information and feel confident enough to take educational risks (Skinner & Belmont, 1993).
- FFA: is an intracurricular student organization for those interested in agriculture and leadership. It is one of three components of agricultural education (National FFA Organization, 2015).
- Lesson plan: a detailed description of the individual lessons that a teacher plans to teach on a given day (Meador, n.d.).
- Problem-based learning: is a student-centered pedagogy in which students learn about a subject through the experience of solving an open-ended problem. Students learn both thinking strategies and domain knowledge (Merriam-Webster, n.d.).
- Rubric: a grading or scoring tool that lists the criteria and expectations of a particular assignment by describing levels of quality for each of the criteria as a means of providing support and guide learning (Carnegie Mellon University, n.d.).
- STEM: an acronym that signifies education (teaching and learning) in the fields of science, technology, engineering, and mathematics (Gonzalez & Kuenzi, 2012).

### **Limitations**

Limitations of this project include the amount of time to develop and have the materials evaluated by more teachers. Experts were purposefully chosen for the panel; however, a larger number of experts were needed to add validity to the project. Another limitation to this project

was creating resources without comparisons and other frameworks, as there are none available at this time for Virginia.

### **Significance of the problem**

Virginia, as well as other parts of the United States, is seeing a decline in students pursuing agricultural education and STEM careers. This is a result from a lack of public outreach according to the Strategic Review. “A recent poll of scientists found that 42% engaged in no public outreach,” (National Science Board, 2004, p. 4) due to time constraints or a lack of desire to do so. As a result, students are not fully aware of the opportunities with STEM related college degrees and subsequent careers all of which include agriculture. Also found in the Strategic plan, Veterinary assistants and Veterinarian careers are on the rise. This proposed project will help increase public outreach and, as a result, more interest in veterinary science classes and STEM-related pathways on behalf of students and teachers. This project will provide teaching tools for veterinary science teachers.

Although the project will be designed for use with secondary veterinary science students, it is conceivable that educators of other age groups and subjects can use the knowledge presented to benefit the learning of their students. Through peer-led training opportunities and workshops, other agricultural educators will have the opportunity to develop their own lessons and incorporate these activities for use in veterinary science class. Eventually, there could be a multitude of educator-designed activities that would be accessible for all teachers across the curriculum.

## **Chapter II Literature Review**

### **Historical background**

Agricultural education has been an integral part of the United States since the first settlers learned farming practices from Indians. Benjamin Franklin advocated for agriculture in the 1700s (Shelly-Tolbert, Conroy, & Dailey, 2000). The Smith-Hughes Act of 1917 of the United States Congress provided federal funds that “promoted vocational agriculture to train people who have entered upon, or who are preparing to enter upon, the work of the farm” (“Smith-Hughes Act,” 2015). This act promoted, but in some ways isolated, vocational education from other academic settings. The act also stated that teachers in the positions to teach vocational education should have work experience in their vocation. Funds were allowed to pay for teachers with vocational experience, but not academics teachers, through the Smith-Hughes Act. Throughout the 1960s vocational education experienced heavy enrollment growths but during the same time frame technological advances were producing increasing employment dislocation (“Smith-Hughes Act,” 2015).

The Vocational Education Act of 1963 described vocational education as courses used for training students for paid or unpaid employment (Hayward, 1993). Additionally, the Act recognized agricultural education courses as preparing individuals for college studies. This preparation for the workforce can be realized through modified teaching methods that include reflective learning and hands-on engagement. When teachers incorporate experiential learning into their lessons, students acquire real-world knowledge that may assist them in a successful career in an agriculture-related field upon finishing their education. Similarly, constructivism is a relatively recent term used to represent a collection of theories, including discovery learning

(Bruner, 1961), generative learning (Wittrock, 1990), and situated learning (Brown et al., 1991), whose premise described learning based on constructed experiences.

The agricultural education mission states that it “. . . prepares students for successful careers and a lifetime of informed choices in the global agriculture, food, fiber and natural resource systems” (National FFA Organization, 2015, para.3). The model of agricultural education incorporates three main components. These integral components summarize what each agriculture teacher strives to include and master in their local programs. The classroom/laboratory component is completed during daily instruction. Students' Supervised Agricultural Experience (SAE) projects are a form of experiential learning that is completed in conjunction with their class grade. The third component is the FFA, which includes career development events. A local program that truly encompasses and strives for excellence in all of the three areas creates the ultimate agricultural education experience (National FFA Organization, 2015).

There are a growing number of opportunities for students planning careers in veterinary science. The main aspects of veterinary research are grouped as “public health and food safety, animal health and welfare, comparative medicine and emerging issues” (Critical needs for, 2005, para. 1). There is a high demand for qualified veterinarians in these fields of studies (Critical needs for, 2005).

Before entering the veterinary science programs at major universities, a student in most cases must obtain their bachelor's degree in the area of animal science or related field. Students in these studies receive a broad foundation in biological sciences, animal production and management, and biomedical research. Students learn through lectures and practical classes with

animal-based work to gain practical tools, including animal handling (Charles Sturt University, 2014).

Veterinary science is a career path that challenges students in the science field to meet these higher standards. Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM) program only admits 138 new students to their Professional Veterinary Medicine Program each year, however not all students will receive their Doctor of Veterinary Science Degree. VMRCVM students thrive upon hands-on learning, clinical experiences and specialty areas available for study (Who Gets In, 2015). Real-life clinical skills, formal training and experience, as well as contact and handling practices are critical skills to become a successful veterinarian. In order to be considered into veterinary science medical programs, students must be familiar with animals and animal behaviors (Veterinary Medicine & Biomedical Sciences, 2013).

Another career and learning option for Virginia students is through Blue Ridge Community College Veterinary Technology Program. This is a two-year program with an externship for students to gain more experience and apply what they have learned. To be admitted to this program, the student must have a minimum of 35 hours experience. Through this program, there is a multitude of possible career occupations for graduates: veterinary technician for the veterinary hospital, diagnostic/research laboratory, the pharmaceutical industry, zoos/wildlife centers, sales and livestock managers, or veterinary educators (Veterinary Technology, 2015).

### **Virginia Statistics**

With over 300 Virginia Agricultural Education teachers teaching approximately 18,000 secondary students, teachers strive to provide innovative and leading edge education. Six

hundred seventy five students, from 39 schools, are enrolled in the veterinary science course in Virginia for the school year 2015-2016 (C. Woolfolk, personal communication, August 28, 2015). There are over 30,000 students enrolled in agricultural education courses, for 2015-2016 school year, this accounts for 18,000 at the high school level and 12,000 middle school students. These middle school students are taught introductory small animal care which is a pathway for students to gain interest and move through the animal systems pathway to the veterinary science class. Currently, however, more schools are offering the Small Animal Care course. The goal is to enable students to grow into competent leaders who will prove to be competitive in a workforce with the ability to adapt skills to new, innovative careers and even those careers that have not yet been developed. Classroom activities include math and science as well as hands-on work experience and the development of life skills. With these life skills, students are able to discover their career path and visualize success. With 87% of FFA students demonstrating an interest in learning career exploration, 81% wanting to explore college preparation and 81% interested in technology, substantial demand exists for student placement (National FFA Organization, 2015). The FFA offers 24 national career development event (CDE) areas and one activity where FFA members are challenged to a real-life, hands-on test of skills used to prepare them for one of over 300 careers in the agriculture industry. One of these career development events is the area of veterinary sciences (National FFA Organization, 2015). According to research by the National Council for Accreditation of Teacher Education (NCATE, 2015), preparation, knowledge of teaching and subject area knowledge increases teacher effectiveness, retention rates and leads to producing higher achieving students (NCATE, 2015).

## Teaching Strategies

As far back as 1972, a researcher concluded that “. . . education has a great potential for helping the learner in his [or her] ‘evolving’ process by providing him [or her] with meaningful, sequentially organized movement activities” (Harrow, 1972 p. 7). Developing and writing lesson plans can be approached by many different methods. According to Colorado State University’s Teaching Guides, “There is no single formula for writing lesson plans” (Writing@CSU, 2015). Lesson plans can vary from being detailed and written out completely to only a brief outline. Virginia Polytechnic Institute and State University’s School of Education website has several lesson plan templates located in an online course management system, Scholar, for their teaching candidates to use. The outline can assist in creating lesson plans. Additional samples can be found on the Virginia Department of Education website. On a majority of the templates, or at the beginning of the plan, it asks for activities to increase student engagement. Catching the student’s attention and engaging them is a key to successful instruction. A study of engaging FFA members by B.A. Talbert realized that students participate in FFA and agricultural education classes because the classes are challenging, interesting, exciting and open for discussion (Talbert, 2004).

There are a variety of teaching strategies that go hand-in-hand with the three-circle model of agricultural education. Kassem (1992) defined teaching techniques as teacher’s activities in the class to involve students in the subject matter, and requires that students participate in learning activities, share equally with other learners, and react to the learning experience. The teacher also needs to work with students, make the learning place more comfortable, organize his/her lesson plans, and influence students by using different teaching methods. The teaching goals must be adapted to the needs and interests of learners, while teaching strategies should be

carefully used to improve learning and make the subject matter useful. These strategies have been found to be significantly related to students' learning achievement (Kassem, 1992).

Along with the opportunities FFA has to offer students, the Common Core State Standards (CCSS) are the first step in providing young people a high-quality education. These standards are designed to reflect real-world knowledge and skills necessary for student success in college and careers. No longer a basic test, science standards will require real-world scenarios and questions that force students to apply their learning. Higher metacognitive levels will be sought and students will be required to apply the information they have learned (Common Core State Standards Initiative, 2014). While Virginia does not utilize the Common Core System, the alternative Virginia Standards of Learning also demand the same high metacognitive levels sought in the CCSS Initiative.

It is the educator's responsibility to create opportunities in the classroom for students to think critically. One of the first steps in accomplishing this is to have a learning environment that encourages critical thinking (Dixon et al., 2004). Some examples include student discussions, hands-on and problem-solving activities centered on real-life issues, and encouraging students to feel confident enough to take a proactive role in their education (Dixon, et al., 2004). This will require a shift from a teacher-centered classroom to a student-centered classroom (Dixon, et al., 2004).

### **Learning Aids**

Learning aids are devices or mechanisms designed to make learning more effective, efficient, and satisfying, while simplifying and organizing complex content and connecting new ideas to old ones (Yelon, 1996, p. 131). Agricultural Education makes use of a variety of learning aids.

## **Experiential Learning**

Experiential learning is a major component of agricultural education. The term experiential learning is used to describe the sort of learning undertaken by students who are given a chance to acquire and apply knowledge, skills and feelings in an immediate and relevant setting (Learning Styles, 2015). Experiential learning involves a direct involvement with the phenomena being studied rather than simply thinking about it.

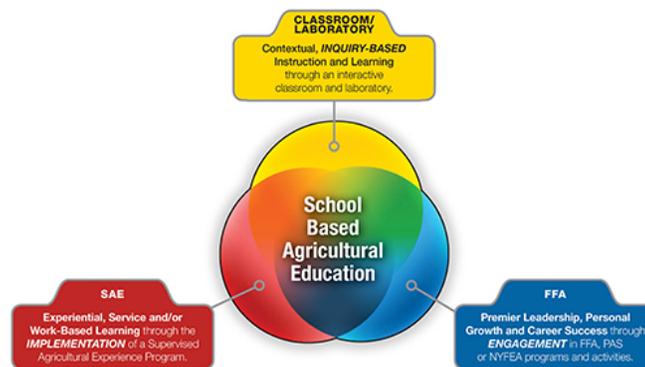
Kolb's Theory was primarily built on the work of Dewey (1938) who recognized the experience in the process of learning; Lewin (1951) who emphasized active participatory learning; and Piaget (1970), who conceived intelligence as a result of the interaction of the individual with the environment. There are four learning stages according to Kolb's Theory of Learning Styles (Learning Styles, 2015). Those four learning stages are: concrete experience: being involved in a new experience, reflective observation: watching others or developing observations, abstract conceptualization: creating theories to explain observations and active experimentation: using theories to solve problems, make decisions.

Kolb (1984) argues that the learning cycle can begin at any one of the four stages and that it should really be approached as a continuous spiral. However, it is suggested that the learning process often begins with a person carrying out a particular action and then seeing the effect of the action in this situation. Following this, the second step is to understand these effects in the particular instance so that if the same action was taken in the same circumstances it would be possible to anticipate what would follow from the action. The third step would be understanding the general principle under which the particular instance falls (Learning Styles, 2015). When the general principle is understood, the last step, according to David Kolb is its application through action in a new circumstance.

Traditionally, agricultural educators have identified SAE programs as the primary experiential learning tool in agricultural education. However, Kolb (1984) asserted that all learning is experiential. Thus, experiential learning plays an integral role in the entire agricultural education model, not just the SAE component. In some representations of the experiential learning steps they are sometimes represented as a circular movement just as the agricultural education model.

Dixon concluded that 20% of knowledge is retained if only abstract conceptualization is used (Stice, 1987). If both reflective observation and abstract conceptualization are used, retention is increased to 50%. If one uses concrete experiences plus reflective observation, and abstract conceptualization, retention rises to 70%. Ninety percent is retained if all four learning stages are employed. As indicated in Figure 2, Agricultural Education offers all four learning stages.

Figure 2



National FFA, 2015

## Problem-Based Learning

One teaching method approach that can provide hands-on experiences is Problem-Based Learning. Problem-Based Learning is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to a complex

question, problem, or challenge. “PBL is an effective and enjoyable way to learn -- and develop deeper learning competencies required for success in college, career and civic life” (Problem Based Learning PBL, 2014). According to Lohman problem-based learning and action learning approaches use strongly learner-oriented strategies. The problem-based learning approach is more likely to promote the ability to solve ill-structured problems (Lohman, 2002). PBL is all about embedding science and other disciplines in a realistic format that engages students’ interest in and out of class, encourages cross-disciplinary discussions of multiple resolutions, and supports extended investigations and decision making (Burruss, 1999). All of these aspects of PBL are skills needed to move forward in veterinary science and be successful. Once they learn to question and to analyze, they want to continue doing so. Students do not want to revert back to pre-PBL. A student enjoying this format is one of the real strengths of Problem Based Learning (Burruss, 1999).

## **STEM**

Science, Technology, Engineering and Mathematics (STEM) education focuses on developing students' 21st century skills including collaboration, teamwork, creativity, imagination, critical thinking, problem solving, initiative, oral and written communication, and global awareness while educating students in those corresponding subject areas. The United States Department of Education has addressed the need expressed by businesses and industries that suggested schools are not prepared to help students enter STEM professions. More specifically, the United States Department of Education has implemented programs to meet the demand for graduates with professional experience (Ed.gov, 2010).

**Workforce**

Professional veterinary magazines have addressed workforce needs in veterinary medicine and found the following: “There is little evidence of widespread workforce shortages, although industry and some areas of academic veterinary medicine are experiencing shortages of veterinarians with advanced training” (Wren, 2012, para. 3). The authors also concluded that “The veterinary profession is losing its presence in food-animal production and care recommending that veterinary schools should create centers of emphasis on food-animal medicine, and new services” (Wren, 2012, para. 3).

There is a growing national need to increase the number of well-trained veterinarian-scientists to meet societal needs (Cornell University, 2014). High level training, flexible curriculum, clinical and research technologies are needed to prepare these students for careers in veterinary sciences (Cornell University, 2014). With the growing demand for students entering veterinary science programs, it is important for students to have as much real life experience as possible. Veterinary science programs are highly competitive, and possessing additional hands-on experience may be a determining factor into being accepted into veterinary science programs. Classroom instruction is critical to meet the increased demand. Veterinary Science courses as well as Agricultural Science courses provide logical placement for such curriculum at secondary level with hands-on/context-based, curriculum supported and recognized by Virginia Department of Education and National FFA as platform for workplace standards.

Agricultural curriculum must meet workforce standards and, furthermore, prepare students for engaging careers. Students need the contextual learning and work-based experiences in preparation for career demands. This leads to the need to develop the classroom curriculum

that moves beyond the scope of basic science. The curriculum must be oriented to standards outlined by these colleges and veterinary science programs (National FFA Organization, 2014).

The integral intra-curricular components of the agricultural education model are classroom/laboratory, experiential learning (SAE), and the FFA. The veterinary science curriculum from the veterinary science Career Development Event (CDE) contest can be applied into the classroom to meet the need to prepare students in the veterinary science field as well as adding these skills and competencies to the agricultural production courses. This combines all three components of the agricultural education model. Where these circles overlap in the center the full agricultural education experience is obtained (FFA, 2015).

### **Critical Thinking**

All students benefit from learning basic critical thinking skills, regardless of their age and level. Critical thinking skills can be applied in all content areas (Shaughnessy, Seevers, & Elder, n.d.). Not all teachers understand exactly what critical thinking is (Dixon, Prater, Vine, Wark, Williams, & Hanchon, 2004). “Critical thinking is not typically a significant part of teacher preparation programs” (Shaughnessy et al., n.d., para. 1). There is a real need for teacher training to help address this issue; the lack of training trickles down to the students in the classroom and affects them in unintended ways. The traditional classroom environment, however, is not always conducive for students to develop critical thinking skills because the current curriculum is not designed as such (Shaughnessy et al., n.d.). Some students do not learn how to become independent thinkers. Without properly incorporating critical thinking skills in the curriculum, some students come to expect instant gratification and struggle to move past the challenges that are present when trying to solve complex problems (Shaughnessy et al., n.d.).

Preparing students with critical thinking skills is essential for the future of agriculture and a career in veterinary science. Previous reports show that incorporating activities and labs into lesson plans in already existing classes is possible. Even if students choose not to pursue a career in veterinary sciences the skills they will gain from learning about the field of veterinary science, and will stick with them for the rest of their lives. Many of these skills can be applied to various other academic areas as well as the processing and cognitive skills can be applied to other fields. The 21<sup>st</sup> century skills taught to students will help them to effectively communicate knowledgably about agriculture in successful ways. Preparing more teachers with the resources needed to engage our students in a dynamic learning environment brings more adequate opportunities to shed light on the complexity of the agriculture industry and the challenges it faces.

### **Theoretical Framework**

There are a variety of models and theories which teachers can use to identify and understand their teaching and learning preferences. Just as there are a variety of strategies teachers can employ for a variety of learners. Though the opportunity for involvement in learning experiences is many in agricultural education, Knobloch (2003) claimed

“the greatest challenge for today’s teachers and students of agriculture is to move beyond the ‘doing’ and ensure that all learning is connected to thinking and knowledge that will be easily remembered and applied later in life” (p. 31).

Kolb’s experiential learning theory (ELT) is effective in explaining the complexities and difficulties of classroom teaching (Kolb 1984). The ELT model and learning style inventory are used to understand the various stages of learning and the different ways people receive and process new information. The ELT model emphasizes a need for learner involvement and the

concept of how experience makes learning meaningful. The learning style inventory is used to match different student learning styles to complex subject matters, understand individual preferences for certain learning experiences and, the adoption of different teaching methodologies which suit various learning styles.

Kolb (1984, p.21) defines experiential learning as a ‘holistic integrative perspective on learning that combines experience, cognition and behavior’. Learning, he further argues is ‘a continuous process grounded in experience’ (1984, p.41). A process through which knowledge is generated as new information and experiences are assimilated. ‘Knowledge results from the combination of grasping and transforming experience’ (Kolb 1984, p.41) Kolb’s four stage model is a simple description of the learning cycle which shows how experience is translated through reflection on concepts, which could be guides for active experimentation and the choice of new experiences. The four stages of the learning cycle are: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC) and active experimentation (AE). Learners go through the cycle several times and therefore the entire process can be described as a spiral of cycles. The learning cycle provides feedback, which is the basis for new action and evaluation of the consequences of the action. Kolb conceptualizes the entire learning process as consisting of four major components: plan, act, observe, and reflect.

### **Summary of Chapter**

Agricultural Education is a large part of history and will continue to be the foundation of our nation. Virginia has a large number of students involved in agricultural education with the opportunity to explore veterinary science. Students can obtain successful careers in a variety of disciplines including veterinary science. Classroom instruction is critical to meet the increased demand for careers available and workforce standards. A variety of teaching strategies and

learning aids can help students be successful. Providing teaching activities to include the four stages of Kolb theory overlapping those steps just as the agricultural education three-circle model overlaps. Students can use each stage or circle to build on the next. Providing a variety of learning aids, such as STEM, critical thinking and problem based learning while keeping in mind the Kolb four stage theory can help students achieve and fully develop their real-life skills and learning capacity. Providing all these learning opportunities together will help prepare our students for a wide-open field of veterinary science. In addition, allowing our students opportunities in a growing national field to fulfill the need of well-trained veterinarian-scientists, this to will help meet societal needs.

## **Chapter III**

### **Methodology**

The purpose of this project was to create resources and activities and to further develop the content in veterinary science curriculum at the high school level. The development of the activities and resources for the class will enhance the students' engagement and understanding, and introduce them to the possible career pathways. This will give the students the opportunity to learn and practice using the skills necessary in a "learn by doing" manner.

The current veterinary science competencies are adopted by the state of Virginia. An industry panel meets to help develop a list of appropriate skills that employees in the field of veterinary medicine will need. The second step in developing the competencies is to have a panel of teachers meet to develop tasks and standards that will serve to teach those needed skills. The standards serve as the basis for the curriculum frameworks. This project adds teaching tools to help teachers heighten critical thinking. The existing curriculum framework is an important factor in developing and preparing lesson plans and activities. However, one key piece to helping teachers is missing; activities and labs that will allow students to use PBL, STEM and critical thinking. These labs will help students to become, or continue to be, 21<sup>st</sup>-century learners. Some activities and labs are required to meet the State Agricultural Tasks, although lessons plans are not restricted to only what is required and may include further topics or ideas.

One lesson activity was created in the area of anatomy and physiology, pertaining to competency #67 -Explain anatomy and physiology of the circulatory system. The unit projects, handouts, worksheets, activities and PowerPoint are included in this sample. These activities provide a variety of learning-by-doing activities (see Appendices A- H).

For Competency #68 - Explain the anatomy and physiology of the urinary tract, lesson development included a sample dissection lab for kidney, dissection lab for students who are absent, and worksheet pertaining to the kidney and how to perform a urinalysis (see Appendices I-L).

With much time, thought, and consideration, activities to include were chosen from the researcher's lesson plans, PowerPoint slides and various teaching tools. All activities were reviewed and used in the high school veterinary science class. Activities chosen were those that could add rigor and relevance to the competencies as well as those that provided hands-on experiences enhance instruction and could be applied to real-world situations through critical thinking and exploration. Further, all of the activities chosen can be used by both beginning and veteran teachers and are adaptable to fit various student learning styles and teacher needs.

After the curriculum and teaching tools were developed, the activities were reviewed and evaluated by an expert panel to determine their feasibility and reliability; students were not involved at any time during the simulation. Multiple modifications were made based upon those evaluations. Special attention was given to aligning the curriculum with Virginia Department of Education Competencies and Virginia Standards of Learning (SOLs). Carefully evaluating each activity and determining what students would be expected to learn in each competency helped with this alignment, as evaluating curriculum and resource effectiveness is important. As a result, two evaluation methods were developed. The first evaluation method is used to gauge what students know prior to beginning the curriculum and compare that to what they have learned after completing the curriculum. Known as a pre-posttest approach, students are given the opportunity to reflect on what has been learned, and teachers have tangible documentation to assess their students' learning. These data were not collected for the purposes of this project;

rather, it is included with the curriculum for teachers to use with their students when using the curriculum. The second evaluation method is to receive feedback from educational professionals as to the effectiveness of the curriculum. Because these curriculum resources are new, feedback will be imperative in order to assess what works well and what should be modified to make it more effective. Data were collected for this evaluation method and will be discussed in greater detail in the chapter entitled Project Outcome.

### **Data Collection**

A panel of professionals, including teachers and administrators, who have expertise in curriculum design and implementation reviewed the curriculum and provided feedback about its effectiveness. The data collected from the evaluation provided guidance as to how the curriculum should be modified to impact student learning. Seven professionals that currently offer at their respective schools or teach veterinary science course 8088 were contacted September 9, 2015 to inquire about their interest and availability in reviewing and providing feedback. Of those seven professionals, five were teachers, two of which were in their first five years of teaching and three who had 10 years or more experience. The other two were administrators. One administrator was a high school principal and the other a Career and Technical Education Supervisor. All seven professional experts used to evaluate the curriculum resources were employed in Virginia school divisions that currently offer the veterinary science course 8088. Curriculum samples were chosen based on the 2014 Virginia Association of Agricultural Educators (VAAE) survey, where teachers asked for help with veterinary science materials in anatomy. The curriculum was sent to the evaluators electronically September 17, 2015, and they were given two weeks to review it. At the end of one week, a Google form was created with evaluation questions pertaining to the curriculum that was sent to each evaluator. The experts were given two weeks to provide

feedback. A Google form account was utilized for all data collection to de-identify survey responses to ensure feedback remained anonymous and maintained subject confidentiality. The Google form allowed for their feedback to be easily captured, and data were immediately updated. Google forms automatically drops data into a spreadsheet form. All averages and calculations were compiled through the spreadsheet.

## Chapter IV

### Project Outcome and Discussion

#### Findings

A professional panel of teachers and administrators reviewed the Veterinary Science Curriculum Resources prior to completing an effectiveness evaluation assessment. Assessment questions were in the form of a five-point Likert scale; the responses were coded accordingly: strongly disagree = 1, somewhat disagree = 2, neutral = 3, somewhat agree = 4, strongly agree = 5. Professionals also had opportunities to provide optional, open-ended responses for each activity. In the following tables, the frequency, along with the percentage, is given for each scaled question. Unedited responses are also provided for the open-ended questions. For the evaluation questions, respondents could only select one response. They were, however, not limited in the number of responses they could give for open-ended questions.

Objective one was to develop curriculum resources and teaching tools such as labs, worksheets, practicums and activities for extensions to the veterinary science curriculum competencies. This was accomplished by developing supplements to aid in further engaging students with hands-on and review activities. The reviewers all evaluated the resources with high marks. They especially liked the hands-on and engaging activities. All respondents felt the resources provided depth and critical thinking skills for students. The labs that provided student design were rated “strongly agree” and added critical thinking for students. All activities and resources were rated “agree” or “strongly agree.” The consensus was that all resources were beneficial and reviewers would like additional resources to be provided for teachers.

Objective two was to prepare and implement sample activities for use in the veterinary science course that meet the Virginia Department of Education State Competencies. Five of the

seven professionals on the panel were teachers and have been able to implement the activities into their own veterinary science classes. For those activities not implemented to this point, all had plans to use each activity.

Objective three was to evaluate the educational effectiveness of the curriculum by receiving feedback from education professionals of veterinary science courses. Specific activity evaluations are shown in the Tables below. Of the 12 resources provided to teachers, eight have been implemented. A panel of professionals reviewed and provided feedback about the effectiveness of the resources for veterinary science curriculum. For each activity, each individual of the review panel answered evaluation questions in the form of a five-point Likert scale; respondents also had opportunities to provide optional, open-ended responses for each activity. Overall, the panel concluded that the curriculum would be beneficial for high school Veterinary Science teachers and would provide collaboration and hands-on learning opportunities for their students; modifications were also recommended to make the curriculum as effective as possible as well as suggestion of providing more notes for teachers.

Finally, one professional responded that two of the activities would serve well as web quest or fill in notes or could be used with PowerPoint. Teachers would need more resources to help students. Thus, more needs to be added to be sufficient help for teachers. The following tables show responses to specific questions for each resource or activity found in the appendices.

**Table 1.***Cruisin' the Heart Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students				2 (29%)	5 (71%)
The teacher could use the activity as presented with no or little alterations.				1 (14%)	6 (86%)

When asked “What specific components worked well with Cruisin’ the Heart?” the professionals said:

- Resources on the sheet were helpful and informative. Students struggling to grasp the concept and information could use them to help make their brochures more informative and gain a further understanding of the materials. They also help to expand on the activity by allowing students to understand disorders that may occur in the heart.
- The evaluation rubric helps to clear up the questions of what components of the circulatory system are considered the “main attractions” and need more emphasis.
- The activity targets all types of learners
- The activity is cross curricular with English and Biology as it expands or emphasizes what students may be learning in biology and encourages correct grammar
- Assignment is simple to grade for the evaluator
- Teacher could use out of the box but modification could be made to differentiate with something like creating a website for the cruise
- Very clear and expectations are well defined
- Like that it is a partner activity

When asked “What specific components could be improved to make Cruisin’ the Heart better?” the evaluators responded:

- Introduction of terms and circulatory system would be needed before students complete
- Publisher seems outdated but could use Google docs

**Table 2.**

*Circulatory System Worksheet, Key and PowerPoint Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent				1 (14%)	6 (86%)
The activity provided hands on learning opportunities for students		1 (14%)	1 (14%)	1 (14%)	4 (43%)
The teacher could use the activity as presented with no or little alterations.				1 (14%)	6 (86%)

When asked “What specific components worked well with Circulatory System Worksheet, Key and PowerPoint?” the professionals said:

- Will allow specifics for review of the circulatory system and reinforcement of what the students have learned and will learn
- Great review of all parts
- The diagrams are helpful and easy to read
- Varied style of questions will be great alternative to a standard worksheet
- Laid out neatly; easy to follow

When asked “What specific components could be improved to make Circulatory System Worksheet, Key and PowerPoint better?” the professionals responded:

- Could this be a web quest, follow along notes, review after lecture but needs more info for teacher

**Table 3.***Observing Circulatory System in Fish Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students					7 (100%)
The teacher could use the activity as presented with no or little alterations.					7 (100%)

When asked, “What specific components worked well with Observing Circulatory System in Fish?” the professionals said:

- Builds on other 2 activities
- Great review of vocabulary and functions
- Students have to use critical thinking as they compare and contrast fish and humans and veins and arteries, capillaries, rate of flow and direction of flow
- Love the comparison with human body and higher order
- What a cool activity!! Love it!!

When asked “What specific components could be improved to make Observing Circulatory System in Fish better?” the professionals responded:

- Procedure says to use cotton ball but roll of cotton may give more protection for fish
- May want to add description of what specifically to look for in blood flow, could have student designated to watch as would be in veterinary medicine – anesthesiologist
- Can other fish be used? Could this be an extension of the experiment to use other types of fish
- How many times can one fish be used in the activity

**Table 4.**  
*Edible Blood Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards				1 (14%)	6 (86%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students					7 (100%)
The teacher could use the activity as presented with no or little alterations.				1 (14%)	6 (86%)

When asked, “What specific components worked well with Edible Blood?” the professionals said:

- Very hands-on activity
- Very easy to follow
- Expands knowledge
- Fill in the blank before starting lab is great introduction or review
- I like teacher has to sign off before moving to next step
- Encourages students to be creative and making in the lab
- Great visual for students
- Very cool lab, like teacher check off before moving on

When asked, “What specific components could be improved to make Edible Blood better?” the professionals responded:

- Are there power points, provide ingredients of the “blood component bag” for teachers; Could have them calculate the grams based on percentages from notes; Repeat the function of each candy to reinforce; Leave more room on worksheet for answers; Will students use previous lecture notes to complete? Need more information for teacher

**Table 5.**  
*Raising the Beat Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards			1 (14%)	1 (14%)	5 (71%)
The content of the activity provided depth of the concept for specified standards			1 (14%)	1 (14%)	5 (71%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students					7 (100%)
The teacher could use the activity as presented with no or little alterations.					7 (100%)

When asked, “What specific components worked well with Raising the Beat?” the professionals said:

- Lab report template is easy to follow and the questions help to explain what is needed
- Hands on clear explicit directions
- Good lead in to animal CPR and first aid
- Like the aspect of working toward experimental design, work well bringing in agriscience fair
- Very hands on, like that they have to design their own

When asked, “What specific components could be improved to make Raising the Beat better?” the professionals responded:

- I would tell my students correct way of using stethoscope in ears to hear
- Will students receive training on take blood pressure? Could incorporate with school athletic trainer or nurse

**Table 6.***Worksheet on Blood Flow Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards				1 (14%)	6 (86%)
The activity structure was logical and coherent				1 (14%)	6 (86%)
The activity provided hands on learning opportunities for students				3 (43%)	4 (57%)
The teacher could use the activity as presented with no or little alterations.				1 (14%)	6 (86%)

When asked, “What specific components worked well with Worksheet on Blood Flow?” the professionals said:

- Easy to follow
- Good activity for blood flow and parts
- Great review leading up to heart dissection lab
- Good review of the heart and blood flow

When asked “What specific components could be improved to make Blood Flow better?” the professionals responded:

- Need resources for teacher who has never taught
- Students are active and learning but not sure it is hands-on
- Students could color parts as they identify them in order to ensure understanding

**Table 7.***Daphnia Heart Function Inquiry Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards				1 (14%)	6 (86%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students					7 (100%)
The teacher could use the activity as presented with no or little alterations.				1 (14%)	6 (86%)

When asked, “What specific components worked well with Daphnia Heart Function Inquiry?” the professionals said:

- To further develops critical thinking and understanding of heart rate
- Great!; very hands on; great idea to have students design their own experiment

When asked “What specific components could be improved to make Daphnia Heart Function Inquiry better?” the professionals responded:

- Students will need basic understanding of how to use microscope
- Instruct students on stage of microscope so as to not crush Daphnia
- On light microscope will the light change the temperature when testing the cold and hot water effect?

**Table 8.***Sheep Heart Dissection Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students					7 (100%)
The teacher could use the activity as presented with no or little alterations.					7

When asked, “What specific components worked well with Sheep Heart Dissection?” the professionals said:

- Great extension piece
- Directions great and detailed, picture help break up a lengthy lab
- Like entire lab, lots good directions, good analysis questions too
- Good observation section of the lab  
Very hands-on
- -Very detailed lab, will help students when they go to college

When asked, “What specific components could be improved to make Sheep Heart Dissection better?” the professionals responded:

- Define adipose and maybe discuss roles of adipose

**Table 9.***Responses to Evaluation Questions for Overall Circulatory Resources*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The objectives of the curriculum were met successfully					7 (100%)
The content of the curriculum provided depth of the concept for specified standards					7 (100%)
The curriculum structure was logical and coherent					7 (100%)
The curriculum provided hands on learning opportunities for students					7 (100%)
The teacher could use the curriculum as presented with no or little alterations.					7 (100%)

When asked, “What specific components worked well with over all activities?” the professionals said:

- Excellent activities
- Most are great hands-on activities, those that are worksheets are necessities to gain
- Greater understanding
- Majority of activities are hands on and require students to develop their own experiment
- Please develop or send me more of what you have, these are excellent much needed activities for young teachers

When asked, “What specific components could be improved to make overall activities better?” the professionals responded:

- Maybe label the worksheets as notes or review instead or provide information for teachers
- More resources on content for beginning teachers

**Table 10.**  
*Urinalysis Lab Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students				1(14%)	6 (86%)
The teacher could use the activity as presented with no or little alterations.					7 (100%)

When asked, “What specific components worked well with Urinalysis Lab?” the professionals said:

- Love the recipe for fake urine
- Lab absolute winner, engaging
- Expands on the objectives
- Provides critical thinking and problem solving through different activities
- Could use in middle school
- Great activity; clever way to make the “urine” helps on a budget

When asked, “What specific components could be improved to make Urinalysis Lab better?” the professionals responded:

- Have legend for microscope observations, visual aids might help
- Teacher teaching for first time may need additional teaching resources in form of resources for them or places the students could search for information, make like web quest

**Table 11.***Coloring Kidney Worksheet Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards				1 (14%)	6 (86%)
The activity structure was logical and coherent					7 (100%)
The activity provided hands on learning opportunities for students				1 (14%)	6 (86%)
The teacher could use the activity as presented with no or little alterations.					7 (100%)

When asked, “What specific components worked well with Coloring Kidney Worksheet?” the professionals said:

- Great straight forward
- Coloring allows students identify function and parts but not delving in hands-on good activity before dissection
- Meets in the needs of visual learners

When asked, “What specific components could be improved to make Coloring Kidney Worksheet better?” the professionals responded:

- Not actual hands on dissection
- Would not change activity allows for review and explore parts and functions
- Add resources of Key for worksheet for new teachers
- Like the coloring activity, color coding
- Provides a solid review or can use as web quest

**Table 12.***Pig Kidney Dissection Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent				1 (14%)	6 (86%)
The activity provided hands on learning opportunities for students					7 (100%)
The teacher could use the activity as presented with no or little alterations.					7 (100%)

When asked, “What specific components worked well with Pig Kidney Dissection?” the professionals said:

- Flags are helpful
- Having Identification worksheet before were helpful
- Well developed, appropriate questions
- Rubric sets good expectations
- Very hands on great activity

When asked, “What specific components could be improved to make Pig Kidney Dissection better?” the professionals responded:

- Not sure what the need to list tools and equipment used to dissect the kidney is, question 5, Nothing in competencies says need to know.
- Could really extend and move this lab up the Bloom’s by developing some more in-depth questions that require students to make connections to other things like circulatory system
- Students may need definition of longitudinal

**Table 13.***Kidney Filtration Lab Responses to Evaluation Questions*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The content of the activity targets specified standards					7 (100%)
The content of the activity provided depth of the concept for specified standards					7 (100%)
The activity structure was logical and coherent				1 (14%)	6 (86%)
The activity provided hands on learning opportunities for students					7 (100%)
The teacher could use the activity as presented with no or little alterations.				1 (14%)	6 (86%)

When asked, “What specific components worked well with Kidney Filtration Lab?” the professionals said:

- Notes great way to start the lab and ensure students understand the components the lab will cover
- Targets all learning types between the notes and the lab
- Nice idea to use beads, recyclable materials so save on budget

When asked, “What specific components could be improved to make Kidney Filtration Lab better?” the professionals responded:

- Some examples of what works best in the components of blood bag for teachers would be nice
- Add closure section or do conclusion questions

**Table 14.***Responses to Evaluation Questions for Overall Urinary System*

	Strongly Disagree 1	Somewhat Disagree 2	Neutral 3	Somewhat Agree 4	Strongly Agree 5
The objectives to the curriculum were met successfully					7 (100%)
The content of the curriculum provided depth of the concept for specified concept				1 (14%)	6 (86%)
The curriculum structure was logical and coherent					7 (100%)
The curriculum provided hands on learning opportunities for students					7 (100%)
The teacher could use the curriculum as presented with no or little alterations.				1 (14%)	6 (86%)

When asked, “What specific components worked well with Activities overall urinary system?” the professionals said:

- Materials apply to all learning styles and allows for students to expand on the information they need to learn
- Definitely a solid curriculum activities
- All great activities, very hands on

When asked, “What specific components could be improved to make Activities overall urinary system better?” the evaluators responded:

- If determining an order for labs to be used, put the urinalysis report at the end as culminating lab
- If all resources were similar in make-up, students could more easily follow
- Again adding power points, book references, websites, videos will help the beginning teacher

**Reflection**

As a teacher of Introduction to Veterinary Science for the last nine years who has taught 23 individual classes, some of the limitations to teaching the course are included here. One problem teachers may find is the amount of funding needed for the course. Finding funding during budget crisis can become a limitation. The resources provided in this project were based on a limited budget. The materials used for the practicums and sample organs for the dissections may also pose problematic. Solutions to the budget problem could be to share with science departments and work with the local slaughter facility to obtain organs to dissect. In addition, the teacher should allow students to work in groups and learn in a cooperative education setting, which also reduces costs. An additional problem could be laboratory space because most agriculture departments were not built to incorporate these types of labs and exercises. The project includes lab space needed to perform practicums on the high school campus. The veterinary science class is often taught in a regular classroom, that may not have any lab stations/counters to perform practicums on or a sink to clean up during, before and after live practicum. Tables covered with trash bags can serve as a dissecting tray. A third variable for teaching the class is the amount of anatomy or physiology background the teacher may need to be comfortable in presenting materials. Learning with the students is always fun as well as an added bonus that would offset any limiting factors.

## Chapter V

### Conclusions and Recommendations

#### Conclusion

The problem arises in the fact that resources available for teachers to use in implementing the skills needed for all three aspects of the agricultural education program are limited in Virginia. Resources for a mentor program to help teachers understand various aspects of curriculum and task lists as well as resources to use are not available. Virginia Department of Education provides a list of competencies and tasks for each course through VERSO (Virginia's CTE Resource Center). However, the information provided for teachers is only a framework. With the absence of curriculum writers in the state of Virginia, beginning teachers, as well as veterans, are always looking to others and searching for ways to improve their classes. Teachers are seeking resources to execute and facilitate learning in the classroom. Teachers today find that students learn in the model set up for agricultural education through hands on activities or PBL, and an increasing desire to provide what each student needs. Agriculture is a highly technical, ever-changing industry; an industry upon which everyone is dependent. Surveys sent out by Virginia Association of Agricultural Educators (VAAE) over the past two years have indicated the need for professional development and resources. Agricultural Education Teachers have requested workshops for ideas to implement the state competencies into their curriculum. In order for our teachers to move forward in providing skills to students to prepare them for careers in the 21<sup>st</sup> century they need resources to provide a more dynamic learning environment.

Although, traditionally, SAEs have been referred to as the experiential component of the agricultural education model, each of the three components included in the agricultural education model must encompass rich experiences. The experiential learning cycle provides a good

framework to compliment the existing agricultural education model. The three components of agricultural education fit into the experiential learning cycle. The formal instruction seems to be more related to the abstract, where FFA is more of the concrete and reflective component. In general, agricultural education teachers are naturally covering a lot of the learning emphasis on the different modes of the learning cycle.

These curriculum resources in this project provided hands-on, inquiry-based and STEM type activities for students to actively participate in their own learning and engaging in critical thinking. The resources have a variety of activities to add diversity to student learning. With the curriculum, students are engaged in problem solving and critical thinking, and as a result, it is anticipated that they will learn the science-related content in a much deeper way. Professionals were not asked to evaluate the correlation with SOLs because it was outside the scope of this project. However, that would be beneficial to teachers in preparing lesson plans and co-curricular activities.

### **Recommendations Based on the Study**

**Recommendation 1:** Include more background information for teachers and, additionally, have more teachers across the state use and evaluate the resources. 100% of those professionals surveyed expressed a desire not only for more resources for veterinary science but also for the resources provided in this project. Many teachers are not experts in veterinary science or all areas within the curriculum competencies. This would allow for more background information as well as providing more resources for teachers to develop.

**Recommendation 2:** Gather a larger and more random sampling of experts for the panel and evaluation. More ideas from individuals can only make resources available to

teachers more useful. In addition, the diversity can provide activities that will reach a larger population of students with various learning styles.

**Recommendation 3:** Train and facilitate workshops for teachers with possibly developing videos of effective lessons. This can help train teachers and give ideas for effective lessons and activities but will also provide an excellent opportunity for teachers to incorporate what they have learned, laying the foundation for STEM curriculum. Use these activities as ideas on how to add more hands-on, inquiry and problem based education to students.

**Recommendation 4:** Update resources every five years based on the VDOE competency and task list updates. Curriculum review teams already evaluate competencies every five years with business and industry and teachers. This will allow the curriculum, activities and resources to stay current and move with the evolution of the industry.

**Recommendation 5:** Include more rubrics for each activity. These rubrics will help teachers to evaluate based on performance just as in industry but also more evenly across the state to better prepare for the workforce. Furthermore, each competency should be examined and resources added for each.

**Recommendation 6:** For the activities that are considered worksheets, incorporate these into a Google drawing document. Using Google draw will appeal to the kinesthetic learner and make these learning activities more appealing to a majority of students.

**Recommendation 7:** The expert panel should evaluate the correlation of these curriculum materials with Virginia SOLs.

**REFERENCES**

- Akella, D. (2010). Learning together: Kolb's experiential theory and its application. *Journal of Management and Organization*, 16(1), 100-112. Retrieved from <http://ezproxy.lib.vt.edu/login?qurl=?url=http://search.proquest.com.ezproxy.lib.vt.edu/docview/346929021?accountid=14826>
- Anderson, L., & Krathwohl, D. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Boston, MA: Allyn & Bacon.
- A Strategic Review of Agricultural Education. (2013). Retrieved August 20, 2015, from [http://www.doe.virginia.gov/instruction/career\\_technical/agriculture/agriculture\\_education\\_report.pdf](http://www.doe.virginia.gov/instruction/career_technical/agriculture/agriculture_education_report.pdf).
- Goodreads*. N.p., n.d. Web. 19 Aug. 2015. <http://www.goodreads.com/quotes/535242-the-farther-back-you-can-look-the-farther-forward-you>.
- Benjamin Franklin. (2002). Retrieved September 1, 2015, from [http://www.pbs.org/benfranklin/13\\_world\\_agriculture.html](http://www.pbs.org/benfranklin/13_world_agriculture.html).
- Brown, J., A. Collins and R Duguid (1991). Situated cognition and the culture of learning. In M. Yazdandi, R. Lawler, M. Yazdani and Lawler (Eds.), *Artificial intelligence and education*. Westport, CT, US: Ablex Publishing. Retrieved from EBSCOhost (1991-98966-006).
- Bruner, J.S. (1961). The act of discovery. *Harvard Education Review* 31. Retrieved from EBSCOhost (1962-00777-001).
- Burruss, J. D. (1999). Problem-based learning. *Science Scope*, 22(6), 46.

- Colorado State University. (2015). College of veterinary medicine and biomedical science. Retrieved from <http://csu-cvmbs.colostate.edu/Pages/default.aspx>.
- Carnegie Mellon University. (n.d.). Teaching excellence and educational innovation. Retrieved from <http://www.cmu.edu/teaching/designteach/teach/rubrics.html>.
- Charles Sturt University. (2014). Bachelor of animal science orientation book 2014. Retrieved from [http://www.csu.edu.au/\\_\\_data/assets/pdf\\_file/0010/821179/animal-science-studenthandbook-2014.pdf](http://www.csu.edu.au/__data/assets/pdf_file/0010/821179/animal-science-studenthandbook-2014.pdf).
- Cheek, J. G., Arrington, L., R., Carter, S., & Randall, R. S. (1994). Relationship of supervised agricultural experience program participation and student achievement in agriculture. *Journal of Agricultural Education*, 35(2), 1–5. doi: 10.5032/jae.1994.02001
- Common Core State Standards Initiative. (n.d.). Implementing the common core state standards. Retrieved from [www.corestandards.org/](http://www.corestandards.org/).
- Cornell University. (2015). Biological and biomedical sciences graduate program. Retrieved from <http://www.vet.cornell.edu/BBS/Scientists/>.
- Critical needs for research in veterinary science. (2005). Retrieved from [http://www.nap.edu/openbook.php?record\\_id=11366&page=21](http://www.nap.edu/openbook.php?record_id=11366&page=21).
- CTE Resource Center - Verso. (n.d.). Retrieved August 11, 2015, from <http://cteresource.org/verso/courses/8088/veterinary-science-tasklist>.
- Dailey, A., Conroy, C., & Shelley-Tolbert, C. (2001). Using agricultural education as the context to teach life. *Journal of Agricultural Education*, 41(1), 11-20. doi: 10.5032/jae.2001.01011.

- "Dixon, F. A., Prater, K. A., Vine, H. M., Wark, M. J., Williams, T., and Hanchon, T. S. (2004). Teaching to their thinking: A strategy to meet the critical-thinking needs of gifted students. *Journal for the Education of the Gifted*, 28(4), 56-76.
- ED. gov. (2010). Science, technology, engineering and math: Education for global 23 leadership. Retrieved from <http://www.ed.gov/stem>.
- FFA. (2015). Career Development Events. Retrieved from FFA: <http://www.ffa.org/CDE>.
- Gerlach, J. (n.d.). Books & Resources. Retrieved August 11, 2015, from <http://www.nsta.org/publications/news/story.aspx?id=59305>.
- Gonzalez, H. B. and Kuenzi, J. J. (2012, August 1). Science, technology, engineering, and mathematics (STEM) education: A primer. Retrieved from <http://fas.org/sgp/crs/misc/R42642.pdf>.
- Harrow, A. (1972). A taxonomy of the psychomotor domain: A guide for developing behavioral objectives. New York: David McKay Company.
- Hayward, G.C. 1993. Vocational Education Act. United States Department of Education. Office of Vocational and Adult Education. Washington, D.C.
- Kassem, A. K. (1992). *Teacher Perceptions of Agricultural Teaching Practices and Methods for Youth and Adults in Iowa*. Doctoral dissertation, Iowa State University, Ames, IA.
- Kolb, D.A. (1984) *Experiential learning: Experience as the source of learning and development*, Prentice Hall, Englewood Cliffs NJ.
- Knobloch, N. A. (2003). Is experiential learning authentic? *Journal of Agricultural Education*, 44(4), 22–34. doi: 10.5032/jae.2003.04022

Lohman, M. C. (2002), Cultivating problem-solving skills through problem-based approaches to professional development. *Human Resource Development Quarterly*, 13: 243–261.

doi: 10.1002/hrdq.1029

"Learning Styles." *SpringerReference* (2011): n. page. Web. 9 Sept. 2015.

National FFA Organization. (2015). Agricultural education. Retrieved from

<https://www.ffa.org/About/WhoWeAre/Pages/AgriculturalEducation.aspx>.

Pennington, K.M. 2012. Knowledge and perceptions of a visual communications curriculum unit in Arkansas secondary agricultural classrooms: an impact of experiential learning.

(Unpublished Master's Thesis). University of Arkansas, Fayetteville, AR.

"Problem-Based Learning (PBL) | Learning Theories." Learning Theories ProblemBased

Learning PBL Comments. N.p., 23 July 2014. Web. 1 Sept. 2015. <http://www.learning-theories.com/problem-based-learning-pbl.html>.

Shelley-Tolbert, C. A., Conroy, C. A., & Dailey, A. L. (2000). The move to agriscience and its impact on teacher education in agriculture. *Journal of Agricultural Education*, 41(4), 51-61.

Skinner, E. A. and Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of*

*Educational Psychology*, 85(4), 571-581.

"Smith-Hughes Act." Dictionary of American History. 2003. Retrieved September 9, 2015 from

Encyclopedia.com: <http://www.encyclopedia.com/doc/1G2-3401803899.html>.

Stears, M. and Gopal, N. (2010). Exploring alternative assessment strategies in science classrooms. *South African Journal of Education*, 30(4), 591-604.

- Stice, J. E. (1987). Using Kolb's learning cycle to improve student learning. *Engineering Education*, 77(5), 291-296.
- Talbert, B. A., & Balschweid, M. A. (2004). Engaging students in the agricultural education model: Factors affecting student participation in the National FFA Organization. *Journal of Agricultural Education*, 45(1), 29-41.
- Tesch, J. (2006). Expanding and Enhancing Rural Education Through Agricultural Education. Retrieved August 12, 2015, from <http://www.ruralmn.org/wp-content/uploads/2011/03/Expanding-and-Enhancing-Rural-Education.pdf>.
- Understanding Agriculture: New Direction for Education. (1988). *National Research Council*. Retrieved September 9, 2015, from [https://books.google.com/books?id=S2MrAAAAYAAJ&pg=PA31&lpg=PA31&dq=how+the+vocational+education+act+changed+agricultural+education&source=bl&ots=int8WeVd2X&sig=ZgpzZD6I8iFwPghIH\\_U9M2gXqQ8&hl=en&sa=X&ved=0CFAQ6AEwCGoVChMIwr-d4OLyxwIVSZiACh1M2ggo#v=onepage&q=how%20the%20vocational%20education%20act%20changed%20agricultural%20education&f=false](https://books.google.com/books?id=S2MrAAAAYAAJ&pg=PA31&lpg=PA31&dq=how+the+vocational+education+act+changed+agricultural+education&source=bl&ots=int8WeVd2X&sig=ZgpzZD6I8iFwPghIH_U9M2gXqQ8&hl=en&sa=X&ved=0CFAQ6AEwCGoVChMIwr-d4OLyxwIVSZiACh1M2ggo#v=onepage&q=how%20the%20vocational%20education%20act%20changed%20agricultural%20education&f=false).
- What is Project Based Learning (PBL)? (n.d.). Retrieved September 1, 2015, from [http://bie.org/about/what\\_pbl](http://bie.org/about/what_pbl).
- What Makes a Teacher Effective? (n.d.). Retrieved August 10, 2015, from <http://www.ncate.org/public/researchreports/teacherpreparationresearch/whatmakesateachereffective/tabid/361/default.aspx>.
- Who Gets In. (n.d.). Retrieved September 15, 2015, from [http://www.becomeavet.vetmed.vt.edu/admissions/who\\_gets\\_in](http://www.becomeavet.vetmed.vt.edu/admissions/who_gets_in).

Wittrock, M.C. 1990. Generative process of comprehension. *Education Psychologist* 24, 345-376. DO 1:10.1207/s 15326985ep2404\_2.

Writing@CSU. (n.d.). Retrieved August 1, 2015.

Why Project Based Learning (PBL)? (n.d.). Retrieved August 10, 2015, from [http://bie.org/about/why\\_pbl](http://bie.org/about/why_pbl).

Veterinary medicine & biomedical sciences. Retrieved August 11, 2015, from <http://vetmed.tamu.edu/dvm/future>.

Veterinary Medicine & Biomedical Sciences. (2013). Prerequisites: Experience with animals.

Retrieved from <http://vetmed.tamu.edu/dvm/future/prerequisites> When, G. (2012, 06 05). Report: Workforce needs in veterinary medicine. *Bovine Veterinarian*.

Veterinary Technology. (n.d.). Retrieved September 15, 2015, from <http://community.brcc.edu/vettech/index.php/admission/>.

Yelon, S. L. (1996). *Powerful Principles of Instruction*. Lansing, MI: Longman Publishers.

These resources were intended for agricultural education veterinary science course 8088.  
Appendix A- L enhance the following competency from the Virginia Department of Education  
Verso CTE Resource

**#67 Explain the anatomy and physiology of the circulatory system.**

- Explanation should include
- Identification of the components of the circulatory system, including the major parts of the heart and the path of blood flow throughout the heart
- The function of the circulatory system
- Common disorders of the circulatory system.

**Process/Skill Questions**

- What are the normal constituents of blood, and what are their functions?
- What is the relationship of plasma to the solvent ability of blood?
- What are the functions of blood?
- What are the four characteristics of blood? How are they alike and different?
- What are the steps in blood clotting, including the role of platelets?
- What is the route of blood circulation through the cardiovascular system?
- What is coronary circulation, and why is it critical even though the heart chambers contain blood?
- What are the different parts of the cardio cycle?

**Appendix I – L**

**#68 Explain the anatomy and physiology of the urinary system.**

- Explanation should include
- Identification of the components of the urinary system, including differences between the male and female urinary tracts
- The function of the urinary system, including the three phases of urine production
- Common disorders of the urinary system.

**Process/Skill Questions**

- What is the function of the kidneys?
- What factors affect kidney function and urine formation?
- How would you describe the formation of urine, including flow through the kidneys?
- Why is the urinary system essential to an animal's health?
- How would you explain the kidneys role in maintaining acid-base balance?
- What are the normal characteristics of urine?
- How would you describe the normal constituents of urine?
- What lab tests are used to evaluate urine including the normal expected ranges of each test?
- What are the consequences when waste is not effectively removed from the body?

**Appendix A**

Name \_\_\_\_\_

**Cruisin' with the Heart****Purpose**

On a recent FFA trip, you picked up a colorful and interesting travel brochure for a cruise. The pages were filled with descriptions of each stop, documenting the location, attractions, and highlights of the destination. It was a good tool to explain the route and benefits of the trip. Could this tool be used to describe body systems?

Like a cruise, there is a specific sequence of stops that are followed within the circulatory system. At each stop along the way, a specific function is completed so the system works efficiently. Oxygen rich blood is pumped to the rest of the body to fuel cells. Oxygen depleted blood is pumped to the lungs to replenish oxygen levels, and then back to the heart for distribution to the rest of the body. Charting the flow will lead to a better understanding of the circulatory system.

**Materials****Per pair of students:**

- Computer with Internet access and Microsoft® Publisher or comparable program
- Sample travel brochures
- Pencil, colored pencils, markers
- *Agriscience Notebook*

**Procedure**

In this activity, you will develop a travel brochure mapping the course of blood through the circulatory system. You will describe each “attraction” or part of the circulatory system in detail as the journey moves along.

1. On a piece of paper, map the route the blood travels through the components of the circulatory system and the functions of those components. This will serve as an outline as you complete the brochure.
2. On a computer\*, open Microsoft® Publisher or Google docs and select a trifold brochure as your publication type. \*You may choose to use your artistic abilities and draw.
3. Place information about each component and its function into the brochure as if each were a separate attraction on a tour. Attractions in a real travel brochure are written to sound fun and appealing in order that travelers will be excited about stopping there. Utilize the same language and style in your brochure. Use *Circulatory Evaluation Rubric* as a reference while developing your brochure.
4. The parts of the heart are the main attractions; extra emphasis should be placed on these components.
5. Add a diagram of the entire system and other pictures and diagrams as necessary.
6. Print your brochure, attach the front to the back and fold it accordingly.



**Cruisin' with the Heart Evaluation**

<b>Topics</b>	<b>4 points</b>	<b>3 points</b>	<b>2 points</b>	<b>1 point</b>	<b>Teacher Comments</b>
<b>Content and Accuracy</b>	Accurately describes the circulatory system and includes the heart, arteries, veins, and pulmonary circulation.	One inaccurately described component or is missing one of the following items: • Heart • Arteries • Veins • Pulmonary circulation	Two inaccurately described components or is missing two of the following items: • Heart • Arteries • Veins • Pulmonary circulation	Three inaccurately described components or is missing three of the following items: • Heart • Arteries • Veins • Pulmonary circulation	
<b>System Requirements</b>	All parts of the circulatory system and their functions are clearly present in the brochure.	No more than one part of the circulatory system or function missing from the brochure.	No more than two parts of the circulatory system or functions missing from the brochure.	Three or more parts of the circulatory system or functions missing from the brochure.	
<b>Diagrams and Pictures</b>	Diagrams and pictures are neat. All components are clearly labeled on the diagram.	Diagrams and pictures are neat. One to two components are not clearly labeled on the diagram.	Diagrams and pictures are readable. Three to four components are not clearly labeled on the diagram.	Diagrams and pictures are messy. Most components are missing from the diagram.	
<b>Creativity</b>	Concept of the brochure is unique and creative. Uses technology and artistic abilities.	Concept of the brochure is relevant. Uses technology and artistic abilities.	Concept of the brochure is generic. Use of technology and artistic ability is limited.	Concept of the brochure is not original. Does not use technology and artistic ability.	
<b>Grammar and Spelling</b>	There are no grammatical or spelling errors in the travel brochure.	There are one to four grammatical or spelling errors in the travel brochure.	There are five to ten grammatical or spelling errors in the travel brochure.	There are more than ten grammatical or spelling errors in the travel brochure.	
<b>Overall Comments</b>					

**Appendix B – Circulatory System**

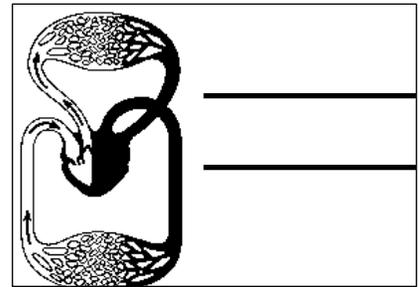
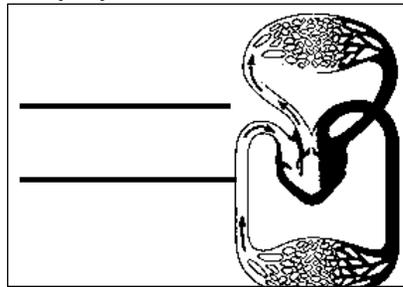
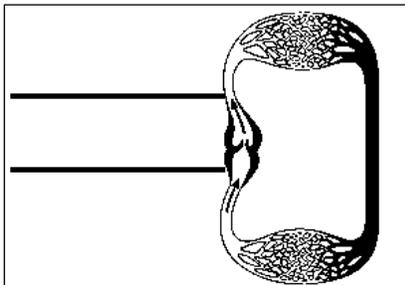
\*\* Use as web quest or with notes from power point

Name: \_\_\_\_\_ Date: \_\_\_\_\_

◆ **What is the Circulatory System?**

\_\_\_\_\_  
\_\_\_\_\_

**Three Primary Types of Circulatory Systems:**



*What animals have these types of circulatory systems?*

◆ **The Parts of the Circulatory System- Blood**

- The liquid that \_\_\_\_\_ in the blood vessels,  
\_\_\_\_\_ oxygen, carbon dioxide, waste, etc. around the body.



What is blood made of?

◆ **The Parts of the Circulatory System- Blood Vessels:**

Veins

Arteries

Capillaries

\_\_\_\_\_

\_\_\_\_\_

◆ **The Parts of the Circulatory System- The Heart:**

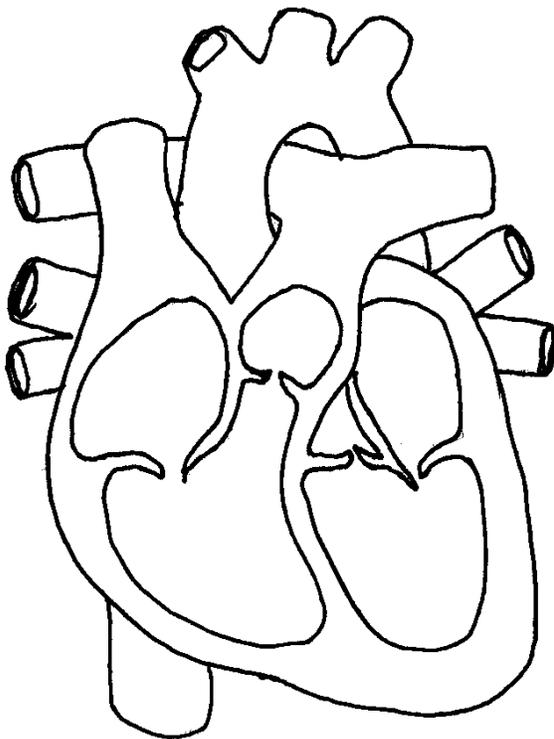
- This is the \_\_\_\_\_ that is involved in \_\_\_\_\_ the blood throughout the body.

- What are the parts of the heart?

**VENTRICLE CHAMBER(s): ATRIUM CHAMBER(s): VALVES:**

- Draw and describe the differences in the parts of 2, 3 and 4 chamber hearts.

-Label each part of the below 4 chamber heart.



*Determine how many chambers each of the following animals' hearts have:*

**Horse:**

**Catfish:**

**Turkey:**

**Pig:**

**Trout:**

**Bull:**

*Where is the heart of a shrimp located?*

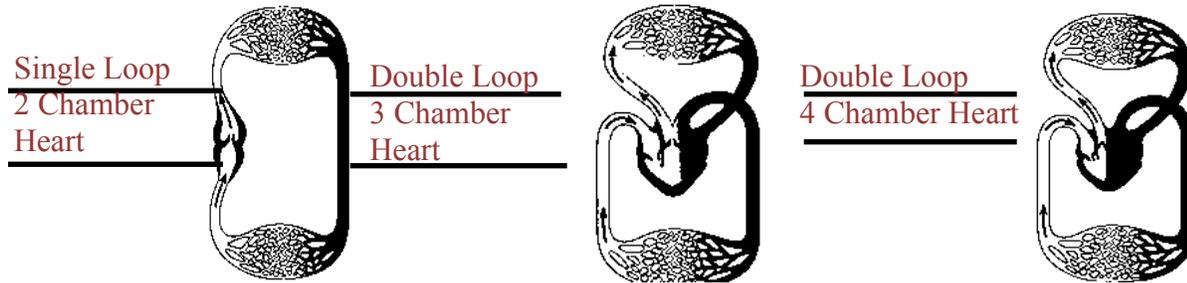
**Appendix B KEY**

Name: \_\_\_\_\_ Key \_\_\_\_\_ Date: \_\_\_\_\_

◆ **What is the Circulatory System?**

An animal’s body system concerned with the transport of blood through the heart, blood vessels and lungs; helps move nutrients, oxygen, waste, etc. around the body.

◆ **Three Primary Types of Circulatory Systems:**



*What animals have these types of circulatory systems?*

Fish

Amphibians Birds

Mammals

**The Parts of the Circulatory System- Blood**

- The liquid that circulates in the blood vessels, transporting oxygen, carbon dioxide, waste, etc. around the body.

- What is blood made of?

Red Blood Cells (erythrocytes)- transport oxygen

White Blood Cells (leukocytes)- defense against infections

Platelets (thrombocytes)- assist with blood clotting

Plasma- liquid that suspends proteins and solid components of blood



◆ **The Parts of the Circulatory System- Blood Vessels:**

Veins

The pathway of oxygenated blood to the heart

Arteries

The pathway of oxygenated blood from the heart to the body

Capillaries

The pathway of oxygenated blood from the heart to the body. Oxygen is transferred to the tissues; Waste from the tissue cells is then transferred into the blood

**The Parts of the Circulatory System- The Heart:**

- This is the muscle that is involved in pumping the blood throughout the body.

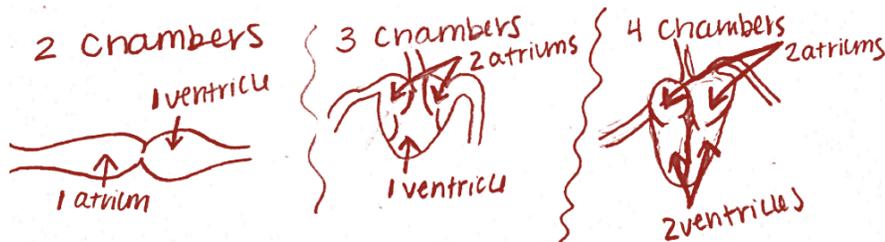
- What are the parts of the heart?

**VENTRICLE CHAMBER(s):**

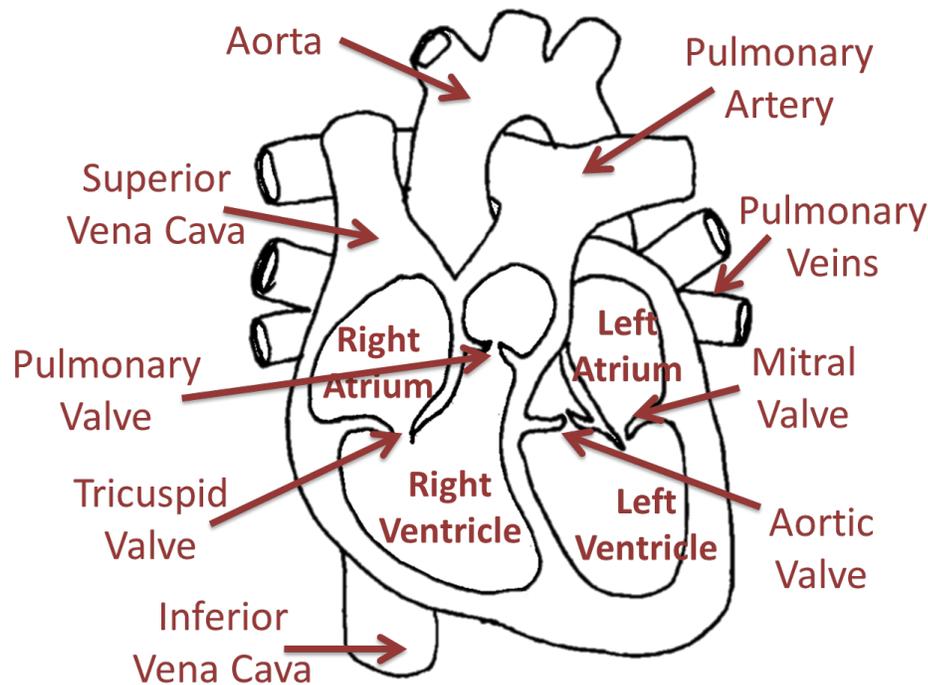
**ATRIUM CHAMBER(s):**

<p><b>VALVES:</b> The chamber(s) that pump the blood out of the heart, to the lungs or body</p>	<p>The chamber(s) that pump the blood into the ventricle chamber(s)</p>	<p>Moving flaps between each chamber that keep the blood flowing in one direction; prevents backwards flow</p>
---	---	--

- Draw and describe the differences in the parts of 2, 3 and 4 chamber hearts.



-Label each part of the 4 chamber heart.



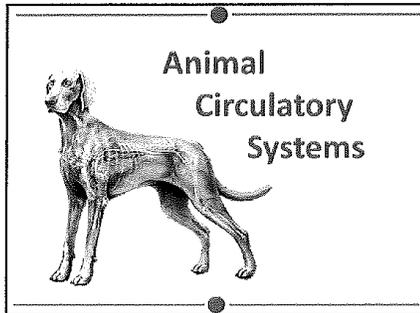
Determine how many chambers each of the following animals' hearts have:

**Horse: 4**  
**Catfish: 2**  
**Turkey: 4**  
**Pig: 4**  
**Trout: 2**  
**Bull: 4**

Where is the heart of a shrimp located? *head*

Animal Circulatory System PowerPoint

12/2/2015



**What is the Circulatory System?**

- An animal's body system concerned with the transport of blood through the heart, blood vessels and lungs.
- Helps move digested nutrients, oxygen, waste, and other materials around the body.

**Do all Animals have a Circulatory System?**

We don't! →

We DO →

**Are all Circulatory Systems the Same?**

**NO! There are 3 primary types of Circulatory Systems:**

- Single loop circulation with 2 Chamber hearts
- Double loop circulation with 3 chamber hearts
- Double loop circulation with 4 chamber hearts

**Are all Circulatory Systems the Same?**

**Single loop circulation with 2 Chamber heart**

Fish have this type of circulatory system!

**Are all Circulatory Systems the Same?**

**Double loop circulation with 3 Chamber heart**

12/2/2015

**Are all Circulatory Systems the Same?**

Double loop circulation with 4 Chamber heart

**How do Humans Compare to Animals?**

**Remember, we are ANIMALS!**

Humans are mammals just like cats, dogs and cows. Our system is the same as birds and other mammals.

**The Parts of the Circulatory System**

**Blood**

**Heart**

**Blood Vessels**

**Think of it like a Highway**

**Blood** – transports cells just like a bus transports people

**Heart** – controls the flow of blood like street lights control the flow of traffic

**Blood Vessels** – lead the flow of blood through the body like a road leads the flow of traffic

**Blood**

The liquid that circulates in the blood vessels, transporting oxygen, carbon dioxide, waste, etc. around the body.

**What is blood made of?**

- Red blood cells
- White blood cells
- Platelets
- Plasma

12/2/2015

### Blood

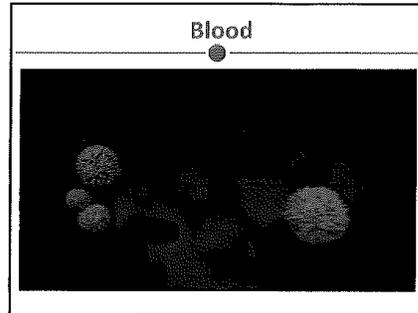
**Blood is made in the bone marrow of the bones**

Solid components:

- **Red blood cells (erythrocytes)** transport oxygen
- **White blood cells (leukocytes)** - fight against infection
- **Platelets (thrombocytes)** - help with blood clotting

Liquid component:

- **Plasma** - Liquid that suspends proteins and the solid components of blood



### Blood

Element	Diameter (in um)
red blood cells	7 - 8
white blood cells	9 - 12
platelets	2 - 4

### Why does the Blood in my arm look Blue?

Actually, blood is always red!

Veins look blue because light has to penetrate the skin to illuminate them, the color that your eyes see is blue.

### Blood Vessels

**Veins:**  
the pathway of oxygenated blood to the heart.

**Arteries:**  
the pathway of oxygenated blood from the heart to the body.

**Capillaries:**  
the small pathways that connect arteries to veins

### Blood Vessels

An animal's blood vessels are located all over the entire body.

They lead oxygenated blood to tissues and organs.

They also lead de-oxygenated/waste filled blood away from these tissues.

12/2/2015

### Blood Vessels- Capillaries

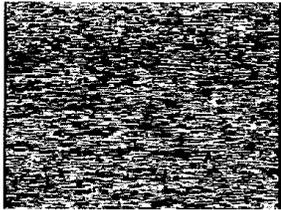
Oxygen rich blood travels from the heart, through arteries.

In the capillaries, Oxygen is transferred to the tissues.  
Waste from the tissue cells is then transferred into the blood

Non-Oxygenated blood returns to the heart to collect oxygen again.

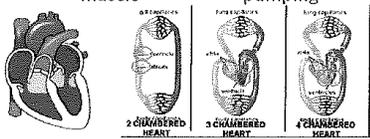


### Blood and Blood Vessels



### The Heart

muscle pumping

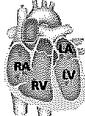


### Heart

Ventricle Chamber(s) the chamber(s) that pump the blood out of the heart, to the lungs or body

Atrium Chamber(s)- the chamber(s) that pump the blood into the ventricle chamber(s)

Valves Moving flaps between each chamber that keep the blood flowing in one direction; prevents backwards flow



### The Chambers of a Heart

**2 Chamber hearts** have 1 atrium and 1 ventricle

**3 chamber hearts** have divided atriums, giving them 2 atriums and 1 ventricle

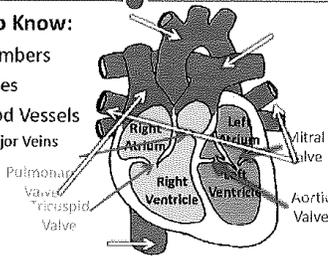
**4 chamber hearts** have divided atriums and ventricles, giving them 2 atriums and 2 ventricles



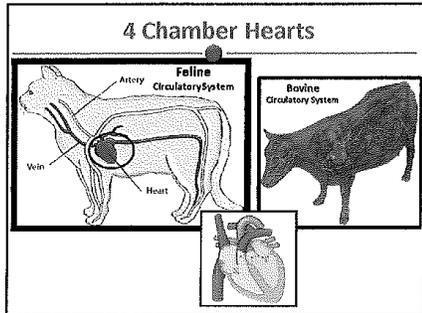
### Lets Focus on 4 Chamber Hearts!

**Parts to Know:**

- ✓ 4 Chambers
- ✓ 4 Valves
- ✓ 5 Blood Vessels
- ✓ 3 Major Veins
- ✓ 2 M



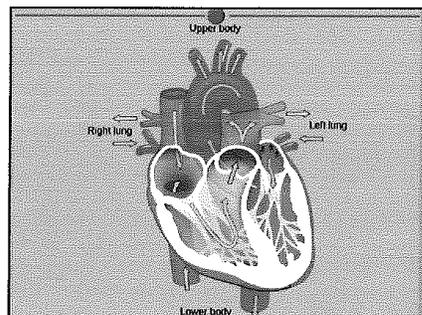
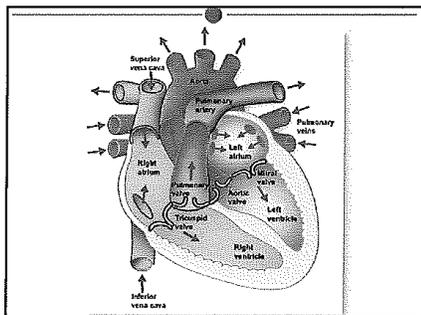
12/2/2015



### Did You Know?!

What Animal has what is known as the "second heart"?!  
**THE HORSE!**

The frog is an important part of the horse's circulatory system—it pumps blood up the horse's leg each time the horse takes a step. The blood flows down the horse's leg, the horse's weight then compresses the frog on the ground, pushing the blood back up the horse's legs.

**Appendix C Observe the Circulatory System in a Fish****\*\* Can use as demo or student lab****Purpose:**

- To examine circulatory system in a fish.
- To distinguish among the types of blood vessels.
- To describe the flow of blood in those blood vessels.
- To compare the structure and function of the blood vessels.

**Materials:**

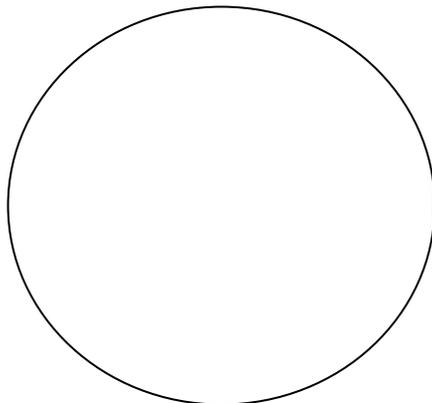
- Goldfish
- Petri dish
- Cotton balls
- Medicine dropper or pipette
- Small beaker of water from goldfish container
- Student Microscopes

**Procedure:**

1. Thoroughly soak a cotton ball in the water in the container that holds the goldfish. Stretch the cotton or unwrap it so that it is a thin sheet.
2. Wrap the fish in the soaked cotton ball leaving only the tail exposed. Have a small beaker or container of water close so that you may add water by using the dropper or pipette as necessary.
3. Carefully place the fish in a Petri dish. The fish may move some, be prepared. Work quickly, but thoroughly; the fish will need to be returned to the water soon. The fish should not be out of the water for more than about five minutes.
4. After raising the objective up so the lens does not touch the fish, place the Petri dish on the microscope stage. Focus the microscope on the tail under low power.
5. Locate the blood vessels in the tail of the fish. Observe them closely. Observe the size of the vessels and the direction of the blood flow in the vessels. Compare the speed at which the blood flows in the various vessels. You may wish to view the fish's tail under medium power. Make sure the cotton stays wet. If you observe the blood flow in the tail stopping, immediately return the fish to its original container.
6. After you have observed the blood flow in the fish, gently return the fish to its original container. Make sure you have carefully removed the cotton from the fish. Do not harm the fish.

**Questions:**

1. Draw what you see when the tail membrane is viewed under low power.



2. Does the blood in all of the vessels travel at the same speed, or at different speeds?
3. Does all the blood flow in the same direction or in different directions?
4. How could you tell the difference between the arteries, veins, and capillaries?
5. What is the function of the arteries in the fish?
6. What is the function of the veins in the fish?
7. What does the flow of blood through the capillaries look like?
8. What is the function of the capillaries?
9. Where in the fish would you expect to find the most capillaries? Why?
10. How is the circulation in the fish similar to the circulation in a human?
11. Why did we cover the fish in wet cotton?
12. How is the circulation in the fish different from the circulation in a human?

**Appendix D Edible Blood –Blood in the Body**

Name: \_\_\_\_\_ Period: \_\_\_\_\_

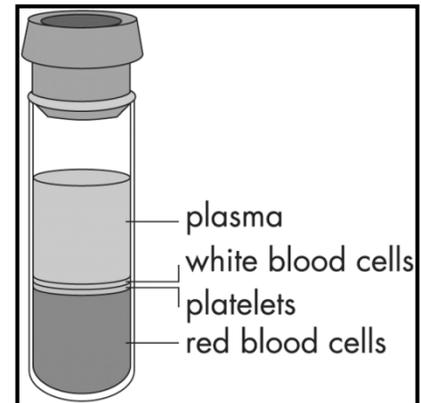
In an animal, blood is the liquid in the circulatory system. All animals have blood, but its nature varies slightly from one species to another. However, the main components and functions of blood are the same in all animals.

Blood, which is vital to the health and survival of all animals, consists of four major components. Blood has five main functions in the body. They are transport of oxygen and carbon dioxide, protection against disease, transport of hormones, transport of nutrients and wastes, and regulation of body temperature.

Complete the follow before the lab. Use the figure to assist with word bank.

✓

\_\_\_\_\_ is the liquid substance in which various solid materials are suspended and moved about. \_\_\_\_\_ is 90 percent water. The other 10 percent consists of glucose, hormones, wastes, minerals, vitamins, proteins, and other substances. \_\_\_\_\_ makes up 50 to 60 percent of blood by volume. \_\_\_\_\_ has a straw color when the solid materials are removed.



✓

\_\_\_\_\_, or **erythrocytes**, are responsible for carrying oxygen from the lungs throughout the circulatory system. The oxygen is carried by a protein part of the blood known as **hemoglobin**. \_\_\_\_\_ have flexible membranes that allow them to squeeze through the very smallest blood vessel. \_\_\_\_\_ do not repair themselves. However, new \_\_\_\_\_ are made in bone marrow. The spleen and the liver remove the dead \_\_\_\_\_. Scientists have found that one animal may possess a trillion blood cells.

✓

\_\_\_\_\_, or **leukocytes**, are responsible for fighting disease and removing harmful substances from the body. Four different kinds of \_\_\_\_\_ are found in blood. Some \_\_\_\_\_ surround and digest infectious bacteria. Other \_\_\_\_\_ produce antibodies. An **antibody** is a kind of protein that destroys bacteria, viruses, and other substances that invade the body. Animals that are diseased produce increased numbers of white blood cells.

✓

\_\_\_\_\_, or **thrombocytes**, are the structures in blood that are responsible for blood clotting. They are not complete cells and have a disk-like shape. In case of a wound, \_\_\_\_\_ stick to the edge of the skin and to each other to form a scab, or cover, that stops the flow of blood. Without \_\_\_\_\_, an animal might bleed to death from a wound.

**Check answers with teacher before moving on to the lab.**

\*\*\*Teacher's initials \_\_\_\_\_

## Edible Blood

### Materials Needed

*Karo Syrup, Red Hots, Sprinkles, Granola oats, Unpackaged Smarties, Dixie Cups, Spoons, Clear Plastic Cup, and a Scale that reads in grams*

### Lab Procedure

Today, you will be asked to make a proportional model of a 50 g sample of blood.

1. In your clear cup, measure 25.4 g of Syrup. (be sure to zero the scale after placing the cup and before pouring the syrup in)
2. Set the clear cup of syrup to the side.
3. Next, using the Dixie cup and a spoon, measure the following ingredients and add them to the syrup. (Remember to zero the scale after placing the Dixie cup and before pouring each ingredient.)
  - 2.6 g of sprinkles
  - 21.8 g of Red Hots
  - 1.1 g of granola oats (you do not have to use whole pieces)
  - 1.1 g of Smarties (you do not have to use whole pieces)
4. Last, mix thoroughly with your spoon!

**Before you consume, answer the questions!**

### Lab Analysis

1. Draw in color what your sample looks like:
  - Plasma-
  - Red Blood Cells-
  - White Blood Cells-
  - Platelets-
3. Why does blood appear red?
4. If the animal was anemic what would blood sample look like? (draw it)

Element	Diameter (in $\mu\text{m}$ )
 red blood cells	7 - 8
 white blood cells	9 - 12
 platelets	2 - 4

## Appendix E Heart Beat – Stethoscope / blood pressure Raising the Beat

### Purpose

Respiration rate, heart rate, and blood pressure – sure you need them to live, but how do they influence the way you live or the way you may raise animals? As long as the heart is beating and the animal is breathing, do you need to worry about these conditions any further? The answer is yes. Maintaining elevated respiration and heart rates over a period of time requires energy. If the rates are normal, the energy may be expended elsewhere, such as for growth or work.

One method of determining the respiration rate of an individual, human or domestic animal is by counting the breaths per minute. If you are the individual breathing, you should not be the counter as the thought associated with counting alters your breathing pattern.

Pulse is determined by counting heartbeats per minute. On people, you count the beats by placing your index and middle fingers over the radial artery in the wrist. It is located in the groove under the thumb. You may also use a stethoscope to listen to the heartbeats.

Blood pressure is necessary to force blood through small vessels and to fight the effects of gravity. Blood pressure is greatest closer to the heart and nearly nonexistent in the small capillary beds. Veins have very low blood pressure. Have you ever seen a cut that spurts blood in bursts compared to a cut that just oozes? The spurting blood is probably from an artery while the oozing blood is probably from a vein. The spurting occurs because of the higher pressure in arteries.

Blood pressure is measured with a sphygmomanometer, or blood pressure cuff, and stethoscope. When the cuff is inflated, the flow of blood through the arm is blocked. When air is released, sounds are created by turbulence as the blood begins to flow through the arteries. The first sound heard is the systolic pressure and when the sound ceases, the diastolic pressure is then determined.

### Materials

#### Per team of three students:

- Stethoscope
- Sphygmomanometer
- Stop watch
- Jump rope

#### Per student:

- Pencil
- Agriscience Notebook
- *Lab Report Template*

### Procedure

In this activity, you will test the effects of a variable on heart rate, respiratory rate, and blood pressure. You will be working with two other students to design and test an experiment addressing heart rate, respiratory rates, and blood pressure.

1. Practice determining respiration rate and taking the pulse and blood pressure of your teammates until each of you has tried all three tests at least once.

**Procedure for Determining Respiration Rate**

- Divide the responsibilities among your team.
  - The person being tested should be seated.
  - One teammate will be the counter.
  - One teammate will be the timer.
- The counter will count the number of breaths the teammate being tested takes in one minute.
- The timer will use the stopwatch to determine when one minute has passed and will tell the counter when to begin counting and when to stop counting.

**Procedure for Taking Pulse**

- Divide the responsibilities among your team.
  - The person being tested should be seated.
  - One teammate will be the counter.
  - One teammate will be the timer.
- The counter will count the beats by placing your index and middle fingers over the radial artery in the wrist of the patient. It is located in the groove under the thumb. Do not use your thumb to take a pulse as it has a pulse of its own.
- Once you can feel the pulse, count the beats for one minute to determine the beats per minute.
- The timer will use the stopwatch to determine when one minute has passed and will tell the counter when to begin counting and when to stop counting.

**Procedure for Taking Blood Pressure**

- To measure blood pressure, the person should be sitting comfortably and relaxed. Sleeves are pushed up and the cuff of the sphygmomanometer is placed on the upper arm.
- Place the cuff on the arm above the elbow approximately level with the heart. Wrap the cuff snugly around the arm.
- Put the earpieces of the stethoscope in your ears.
- Using your index and middle fingers, feel for the pulse in the bend of the elbow. This is the brachial artery. You will feel the pulse beating when you find it.
- Put the diaphragm of the stethoscope over the brachial artery pulse. Listen for the heartbeat.
- Tighten the screw on the bulb and quickly squeeze and pump the bulb. This will cause the cuff to tighten.
- Keep squeezing the bulb until the scale on the gauge reads about 180.
- Slowly loosen the screw to let air escape from the cuff. Carefully look at the gauge and listen to the sounds. Remember the number on the gauge where you first heard the thumping sound.
- Continue to listen and read the gauge at the point where the sound stops.
- The number of the first sound is the systolic pressure.
- The second number is the diastolic pressure.
- When lab is complete - Clean ear piece

2. Working with your team, develop a hypothesis that you believe will cause changes in the respiration rate, pulse, and blood pressure of an individual.
3. Design an experiment testing your hypothesis on the effect of your variable on the respiratory and circulatory systems. You will need to collect evidence that indicates whether or not your hypothesis is correct.
4. Write out step-by-step procedures your group will follow. Make sure the procedure is stated clearly enough that other teams may repeat your investigation.

**Experimental Specifications:**

- Test only one factor.
  - Must designate a “control”
  - Must have a minimum of three trials.
5. Prepare a data table to record your observations.
  6. Conduct your team’s experiment.
  7. Analyze results. What conclusions can you and your team draw from the results?
  8. Individually, use the *Lab Report Template* to prepare a written report that includes a description of the problem, hypothesis, materials, procedure, collected data, analysis and conclusions. Each step of the scientific method must be used and all necessary information should be recorded throughout the course of this paper.
  9. Follow your teacher’s directions for submitting your work.

**Conclusion**

10. What might affect the respiratory and heart rates of animals?
11. How can you as a producer manage the respiratory and circulatory rates?
12. Would an elevated heart rate or respiratory rate be advantageous or disadvantageous to a producer? Why do you believe so?

**Lab Report Template**

Enter the name of the lab here

**Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

Delete the instructions for each section as you complete the section.

**Problem**

What question are you investigating?

**Hypothesis**

What are your predictions? What do you expect the results to be?

**Materials**

List the supplies needed to conduct the experiment.

**Procedures**

List the steps of your experiment here. If this is a structured lab (you were given all procedures), you may refer to the Activity sheet here.

**Data Collection**

What data did you collect? Use graphs, charts, and illustrations to communicate your results.

**Analysis of Results**

Explain the results and data collected. Be descriptive and complete in your discussion.

**Conclusions**

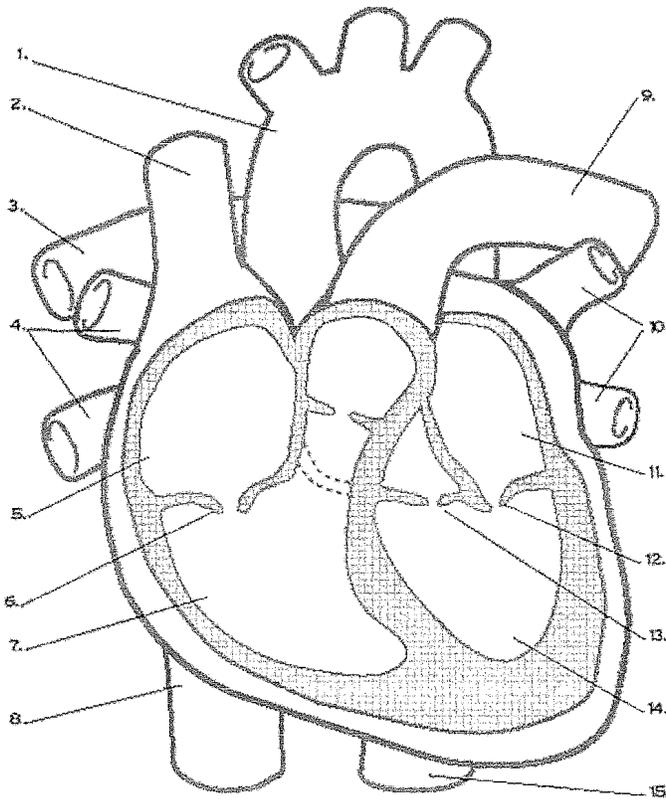
Based on the results, what inferences can you make? Describe how your predictions were proven or disproven. What were possible sources of error? What questions arise based on your results?

### Appendix F Flow of Blood

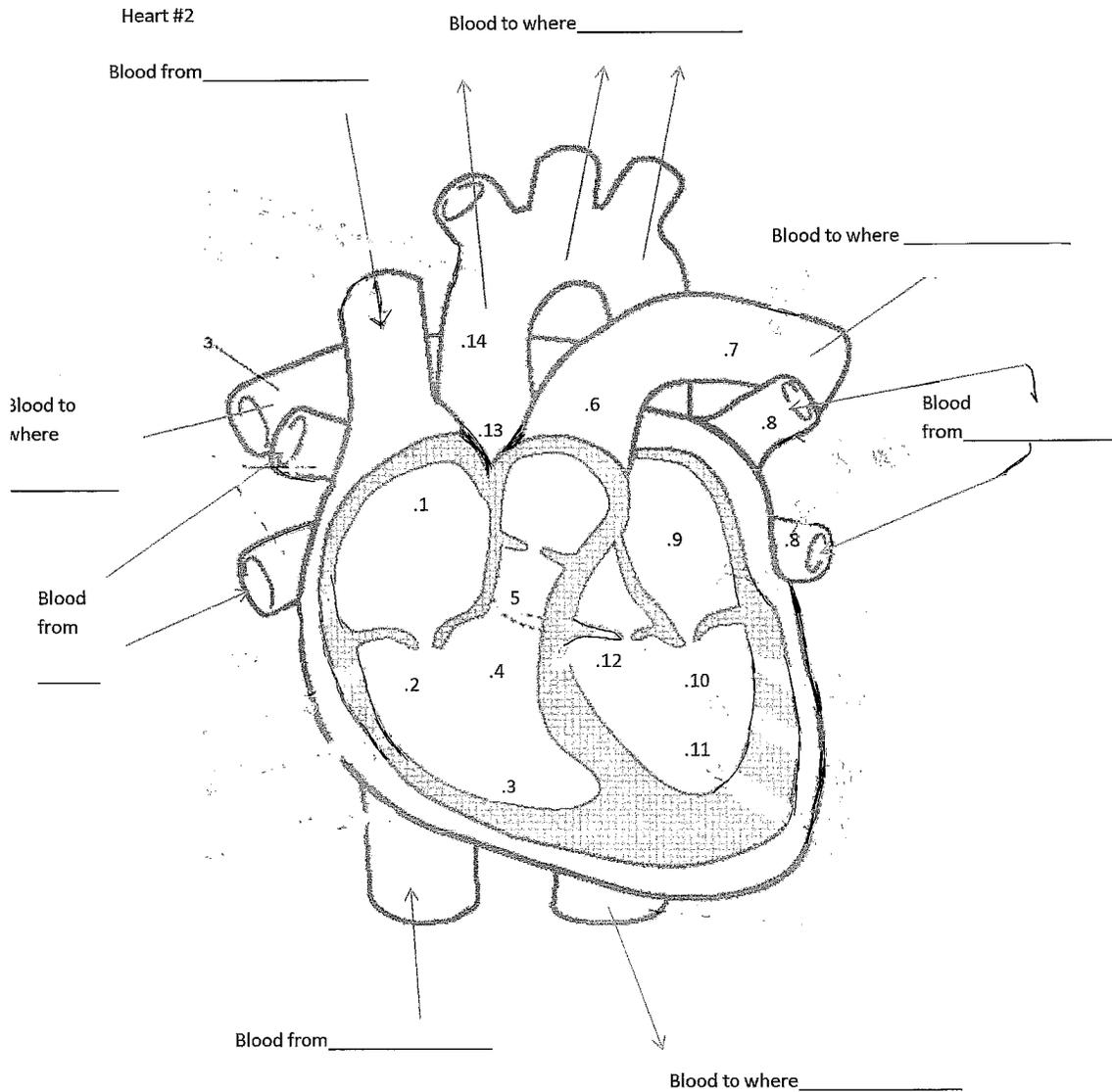
Name \_\_\_\_\_

1. Label the parts of the heart on the first diagram.

Heart #1



2. On the second heart page 2 draw a line to follow the path that blood travels through the heart.
3. Use a blue pencil or marker to connect 1- 7.
4. Use a red pencil or marker to connect numbers 8-14.
5. Label the flow of direction and to where blood goes or comes from.

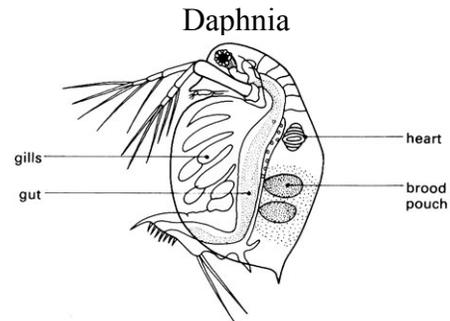


## Appendix G Heart Function Inquiry

### Observation of the Heart of a Daphnia Heart Function Inquiry

#### Materials:

- Daphnia (common name \_\_\_\_\_)
- Microscope
- Microscope slide and cover slip
- Petri dish
- Beakers or containers of cold water
- Beakers or containers of warm water
- Medicine dropper
- Other supplies as requested by students



#### Procedure:

1. Obtain a vial of Daphnia. Do not discard water/pond water.
2. Observe daphnia record your observations:  
\_\_\_\_\_
3. Place a drop of the Daphnia onto a slide, and gently put on a cover slip. Do not press on the cover slip or you will kill your Daphnia. Place the slide on the microscope under the scanning (lowest power) objective. Monitor the microscope stage height as to not crush the daphnia.
4. Focus on the reddish, pulsating object on the back of the Daphnia. This is the heart. Increase the magnification as high as possible, and observe the flow of blood. **Record** the number of heartbeats in a minute. Be sure to watch the heart not the gills. Repeat this step four times for a total of 5 trials, and then take the average of the trials to get the average heart rate. Record the temperature of the water in the petri dish.
5. Design an experiment to test how hot and cold water affect the heart rate of the Daphnia. Make sure you write a question and a hypothesis.
6. Have your teacher approve your research design. Complete steps a-d on page 2 or use lab report template part of Appendix E.  
Teacher initials: \_\_\_\_\_

- a. Question:
  - b. Hypothesis:
  - c. Rationale for hypothesis:
  - d. Experimental Design and Methods:
7. Ok to proceed with your research. \_\_\_\_\_ teacher initials.
  8. Answer the following questions as you Observe the Daphnia:
    - a. Describe what the heart looks like.
    - b. Write the number of beats per minute.
    - c. What happened to the heartbeat when you added the cold water to the Daphnia?
    - d. What happened to the heartbeat when you added the hot water to the Daphnia?
    - e. Why do you think this is?
  9. Complete results and conclusions
  10. Results: (data table and graph) – using Excel or Sheets
  11. Conclusions: (use your data to support your conclusion)

Extension: What other things would you like to investigate about the Daphnia? Design another experiment to test a variable of your own choice.

**Appendix H Heart Dissection Lab**

Name \_\_\_\_\_

Partner \_\_\_\_\_

**Heart Dissection****Directions:**

1. Obtain a preserved sheep heart. Rinse it in water thoroughly to remove as much of the preservative as possible. Also run water into the larger blood vessels to force any blood clots out of the heart chambers.

2. Place the heart on the trash bag with its ventral surface up (“ventral” = the side of the heart closest to your chest). ***Proceed as follows:***

- a. Locate the *visceral pericardium*, which appears as a thin, transparent layer on the surface of the heart.
  - Use a scalpel to remove a portion of this layer and expose the *myocardium* beneath.
  - Also note the abundance of fat along the paths of various blood vessels. This adipose tissue occurs in the loose connective tissue that underlies the visceral pericardium.

b. Identify the following:

*Right Atrium*

*Right Ventricle*

*Pulmonary Artery*

*Left Atrium*

*Left Ventricle*

*Aorta*

3. Examine the dorsal surface of the heart (the side closest to your back).(Fig H – 2)
  - Locate the stumps of two relatively thin-walled blood vessels that enter the right atrium.
  - Demonstrate this connection by passing a slender probe through them.
  - The upper vessel is the *superior vena cava*, and the lower one is the *inferior vena cava*.

**Observation: External Anatomy ( Fig H-1 and Fig H -2)**

Most heart diagrams show the *left* atrium and ventricle on the *right* side of the diagram. Imagine the heart in the body of a person facing you. The left side of their heart is on *their* left, but since you are facing them, it is on *your* right.

- Identify the right and left sides of the heart. Look closely and on one side you will see a diagonal line of blood vessels that divide the heart. The half that includes the entire **apex** (pointed end) of the heart is the left side. Confirm this by squeezing each half of the heart. The left half will feel much firmer and more muscular than the right side. (The left side of the heart is

stronger because it has to pump blood to the whole body. The right side only pumps blood to the lungs.)

-Turn the heart so that the right side is on your right, as if it were in your body. Examine the flaps of darker tissue on the top of the heart. These ear-like flaps are called **auricles**. Find the large opening at the top of the heart next to the right auricle. This is the opening to the **superior vena cava**, which brings blood from the top half of the body to the **right atrium** (the **atria** are the top chambers in the heart). Stick a probe down this vessel. You should feel it open into the right atrium. A little down and to the left of the superior vena cava there is another blood vessel opening.

-Insert your probe into this; it should also lead into the right atrium. This is the **inferior vena cava**, which brings blood from the lower tissues. You can also see another blood vessel next to the left auricle.

- Sticking straight up from the center of the heart is the largest blood vessel you will see. This is the **aorta**, which takes oxygenated blood from the **left ventricle** to the rest of the body (the ventricles are the lower chambers of the heart). The aorta branches into more than one artery right after it leaves the heart, so it may have more than one opening on your heart specimen. Look carefully at the openings and you should be able to see that they are connected to each other.

-Behind and to the left of the aorta there is another large vessel. This is the **pulmonary artery**, which takes blood from the **right ventricle** to the lungs. (Fig H-4)

4. Open the *right atrium*. To do this, follow these steps: (Fig H-5)

- a. Insert a blade of the scissors into the *superior vena cava* and cut downward through the atrial wall.
- b. Open the chamber, locate the *tricuspid valve* and examine its cusps.
- c. Using a spray bottle, run some water through the tricuspid valve to fill the chamber of the *right ventricle*.
- d. Gently squeeze the ventricles and watch the cusps of the valve as the water moves up against them.

5. Open the *right ventricle* as follows:

- a. Continue cutting downward through the *tricuspid valve* and the *right ventricular wall* until you reach the apex of the heart.
- b. Find the opening to the *pulmonary trunk* and use the scissors to cut upward through the wall of the *right ventricle*. Follow the pulmonary trunk until you have exposed the *pulmonary valve*.
- c. Examine the valve and its cusps. (Fig H-8)

6. Open the left side of the heart. To do this, follow these steps: (Fig H-6)

- a. Insert the blade of the scissors through the wall of the *left atrium* and cut downward to the *apex* of the heart.
- b. Open the *left atrium* and locate the four openings of the *pulmonary veins*. Pass a slender probe through each opening and locate the stump of its vessel.
- c. Examine the *bicuspid valve* (mitral valve) and its cusps.
- d. Also examine the *left ventricle* and compare the thickness of its wall with that of the *right ventricle*.

7. Locate the *aorta*, which leads away from the *left ventricle*, and proceed as follows:

- a. Compare the thickness of the *aortic wall* with that of the *pulmonary trunk*.
- b. Use scissors to cut along the length of the *aorta* to expose the *aortic valve*

at its base.

c. Examine the cusps of the valve and locate the openings of the *coronary arteries* just distal to them.

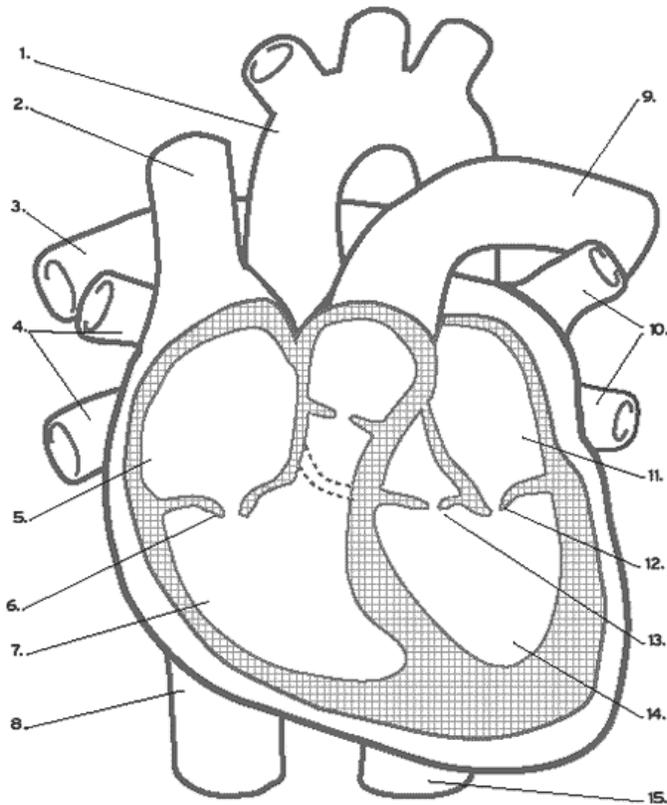
8. As a review, locate and identify the stumps of each of the major blood vessels associated with the heart.

9. Dispose of the heart correctly and clean your lab utensils and space.

10. Answer the following questions

### Heart Dissection Questions!!

Label the diagram of the heart below. Also use a red and blue pencil to draw the flow of oxygenated and deoxygenated blood through the heart.

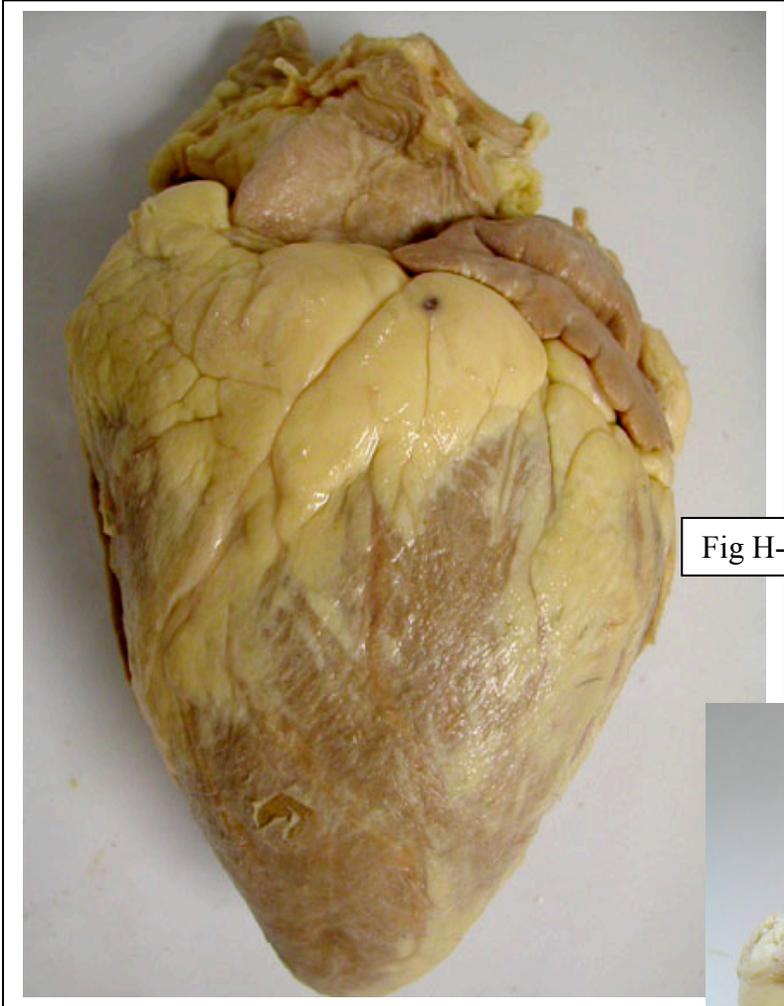


1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____
7.	_____
8.	_____
9.	_____
10.	_____
11.	_____
12.	_____
13.	_____
14.	_____
15.	_____

#### Analysis Questions

1. How can you tell which side of the heart is the ventral surface (the surface closer to your chest)?
2. How many chambers are found in the mammalian heart? List these chambers.
3. Which chambers are the pumping chambers of the heart?

4. Which chambers are the receiving chambers of the heart?
  
5. Describe the action of the tricuspid valve when the ventricle is full.
  
6. Compare the structure of the tricuspid valve with that of the pulmonary valve.
  
7. How do the walls of the atria compare with the walls of the ventricles and why are they different?
  
8. What is the purpose of heart valves?
  
8. Name & compare the heart valves found between the upper & lower chambers of the right and left sides of the heart.
  
9. Vessels that carry blood away from the heart are called \_\_\_\_\_, while \_\_\_\_\_ carry blood toward the heart.
  
10. Which artery is the largest and why?
  
11. The Left Pulmonary Artery can also be called your Left Coronary Artery. What would happen if this was blocked by a blood clot?
  
12. Can an artery carry deoxygenated blood? Explain.



Ventral or Anterior Surface

Fig H-1

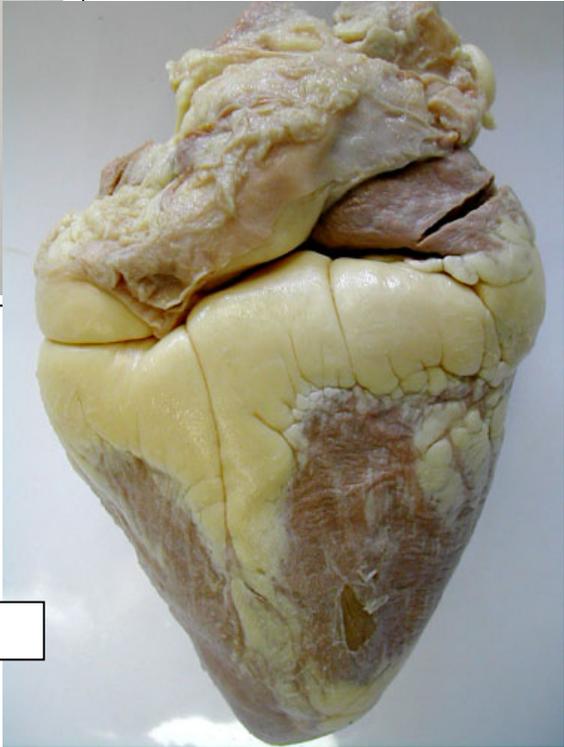
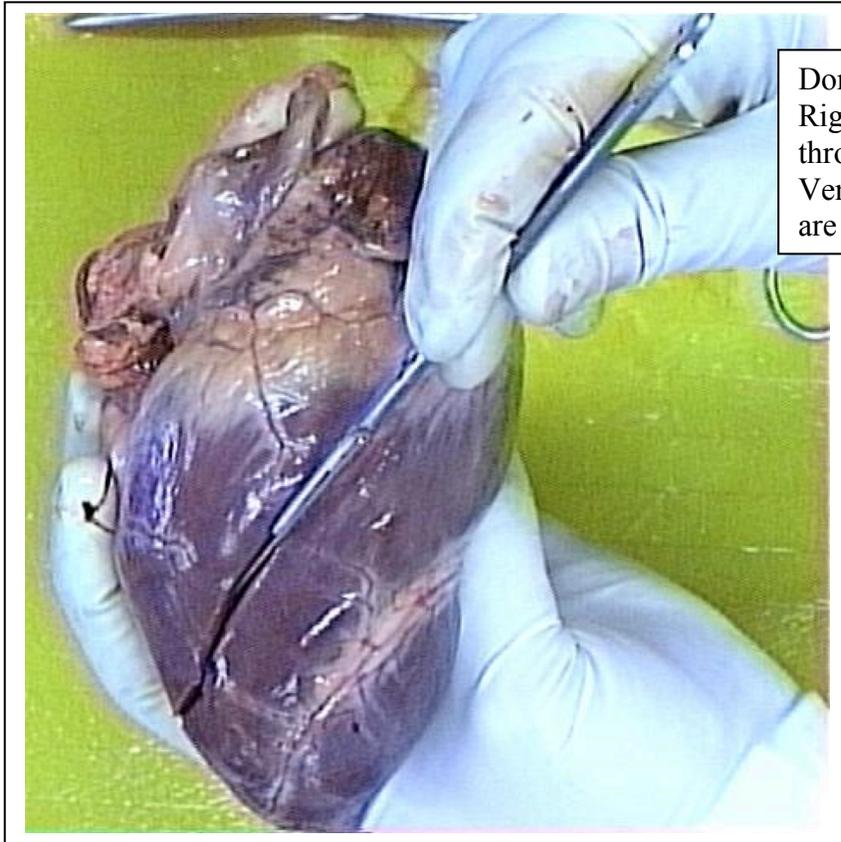
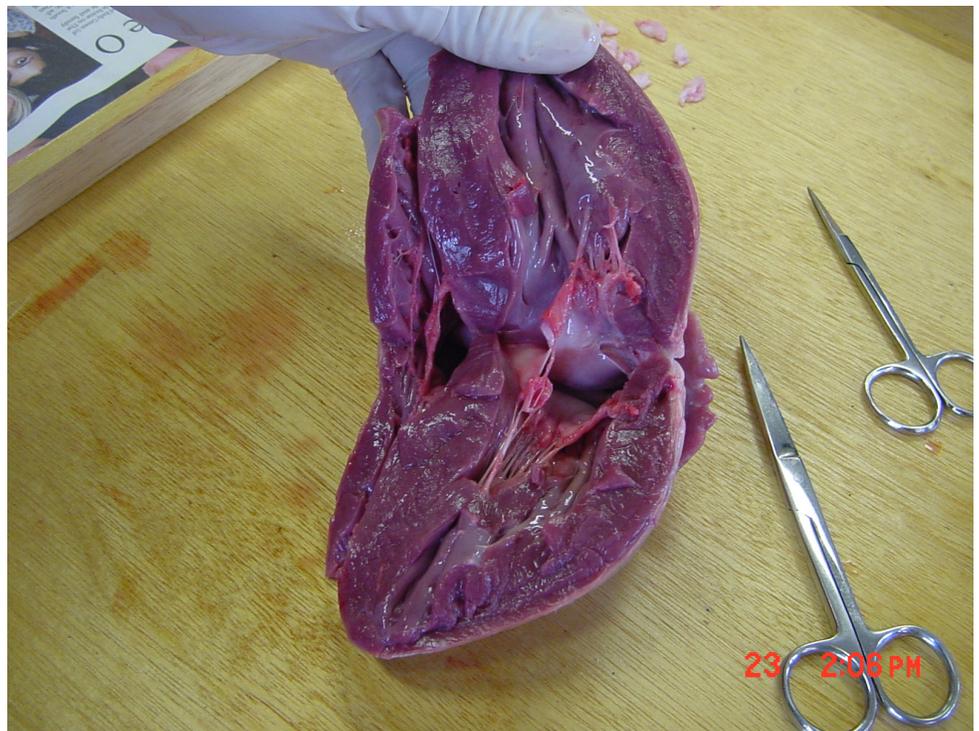


Fig H-2



Dorsal or Posterior Surface  
Right atrium has a partial cut  
through it  
Vena Cava and pulmonary veins  
are not easily located.

Fig H 7



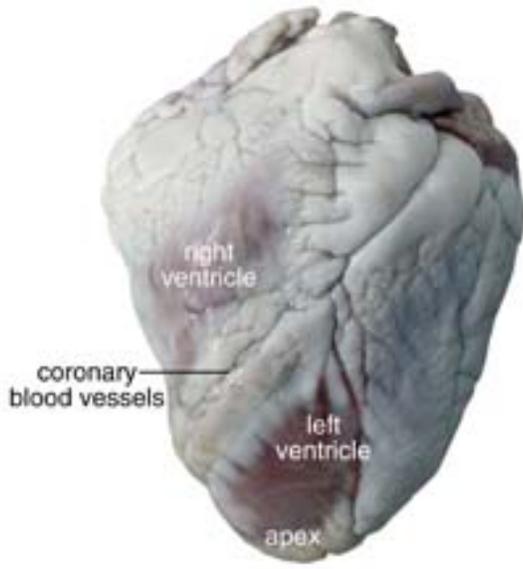


Fig H 3

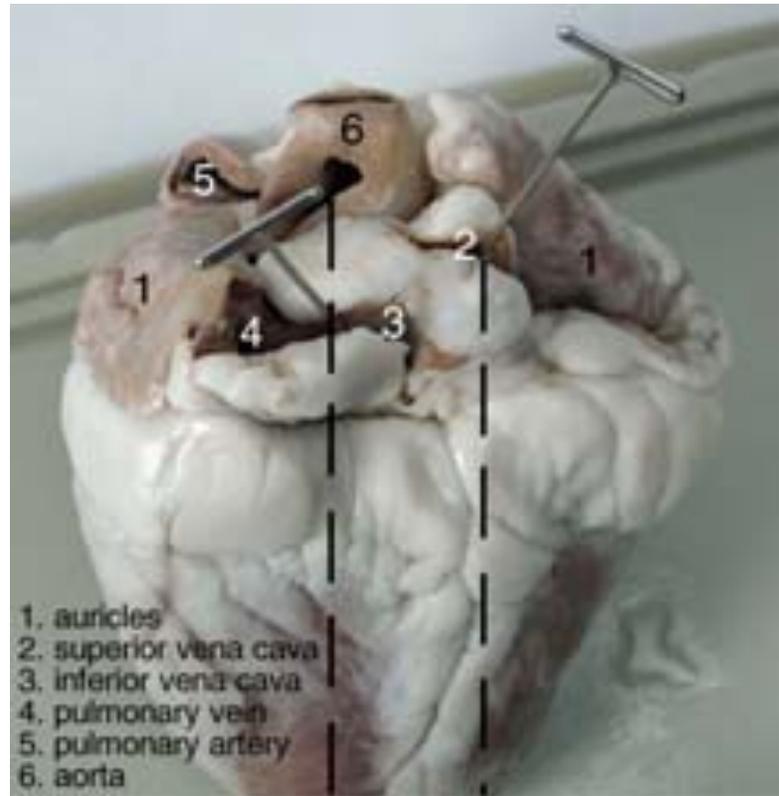


Fig H 4

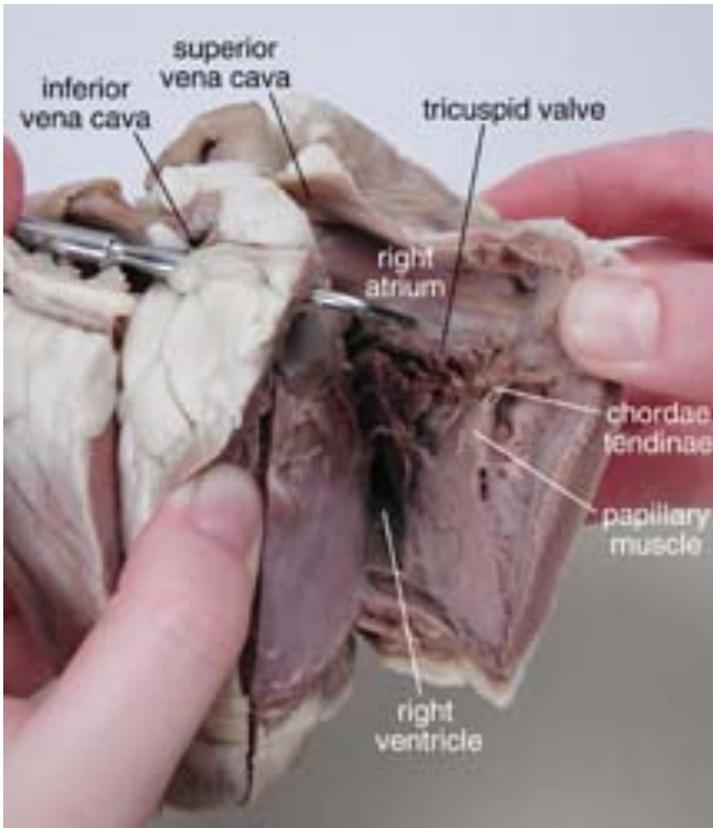


Fig H 5

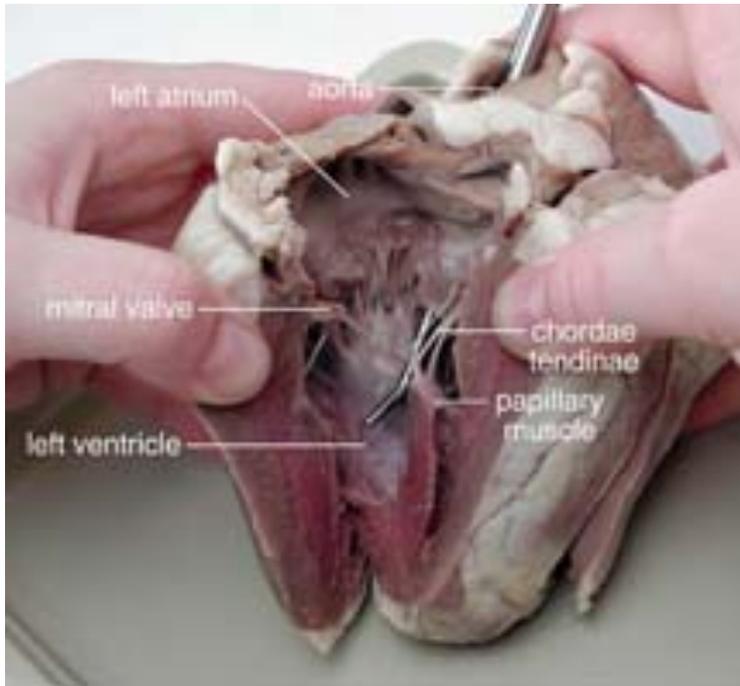
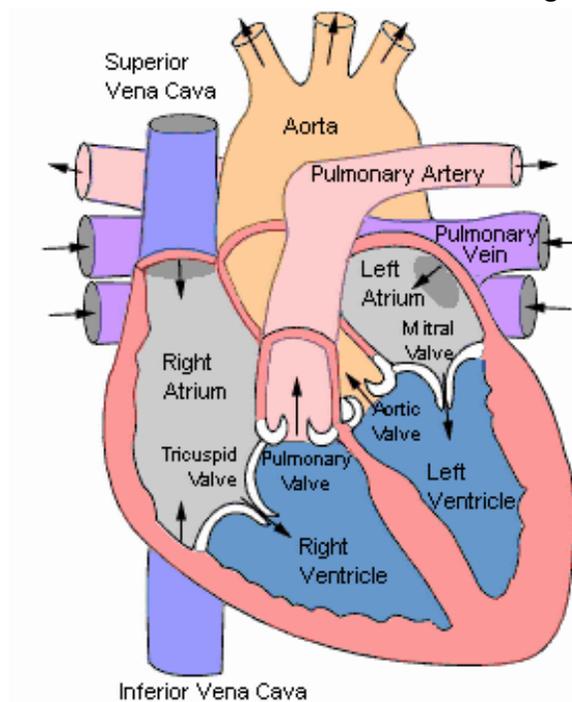


Fig H 6

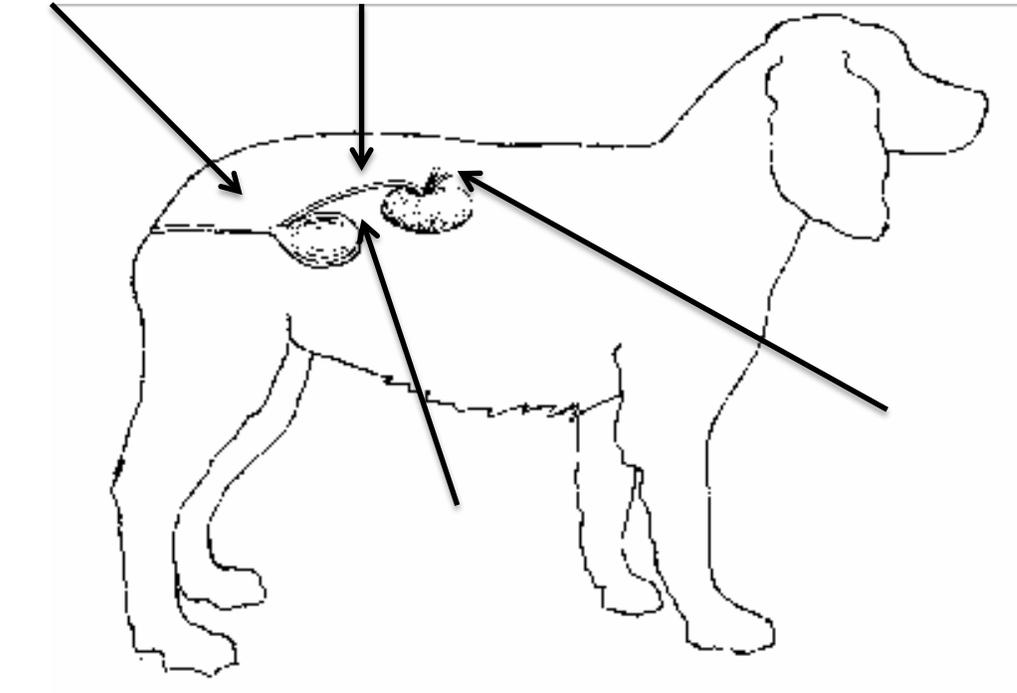
Fig H 8



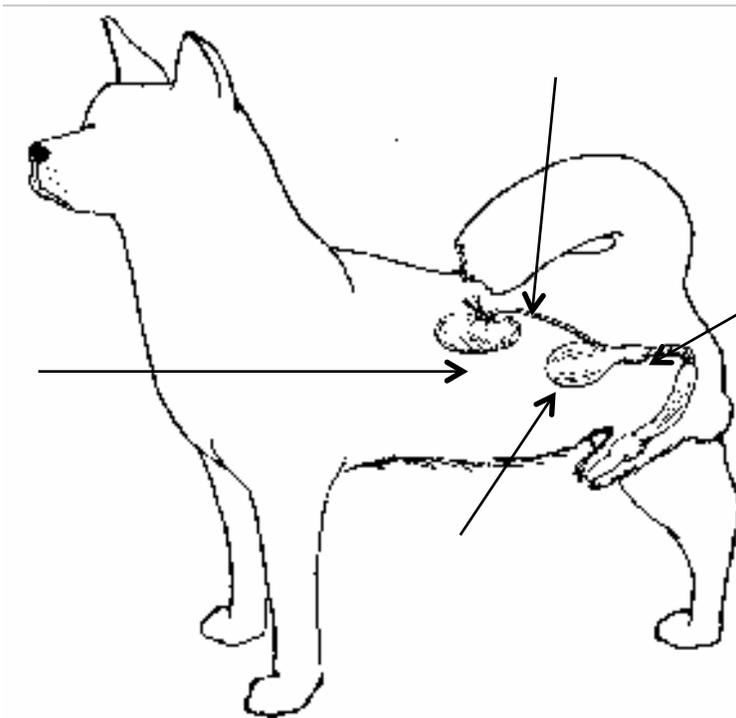
### Appendix I Urinary System Parts Identification and Urinalysis

#### Urinary System Parts Identification

1. Label the parts of the urinary system



Bladder  
Ureter  
Kidney  
Urethra



2. Explain how the male and female urinary systems are different. How do these differences affect functional problems and disease?

### Urinalysis Report

*For each urine sample, make observations about the color and clarity of the urine, and record observations on the table below. Using the urine test strips, dip one strip in the urine for approximately 30 seconds. Place on a paper towel and wait 30-50 seconds. Make observations about each criteria, using the urine strip key, and record information on the table below. Make observations about each patient's microscope slide. Finally, consider all three elements (test strips, observations & microscope slides) and diagnose the patient. Write a diagnosis on the next page, using complete sentences.*

<b>Criteria</b>	<b>Patient #1</b>	<b>Patient #2</b>	<b>Patient #3</b>	<b>Patient #4</b>
<b>Color</b>				
<b>Clarity</b>				
<b>pH</b>				
<b>Specific Gravity</b>				
<b>Protein</b>				
<b>Blood</b>				
<b>Nitrate</b>				
<b>Leukocyte Esterase</b>				
<b>Glucose</b>				
<b>Ketones</b>				
<b>Bilirubin</b>				
<b>Urobilinogen</b>				
<b>Microscope Observations</b>				

**Patient Records****Patient #1:**

**Name:** Lulu **Species:** Canine **Breed:** Mini Poodle **Age:** 10 **Sex:** F **Weight:** 25 lb.

**Patient Symptoms:** Lulu has been drinking more water than normal, and urinating frequently. Her owners became concerned when she began vomiting today.

**Diagnosis:**

**Patient #2:**

**Name:** Beau **Species:** Canine **Breed:** Yellow Lab **Age:** 3 **Sex:** M  
**Weight:** 70 lb.

**Patient Symptoms:** About 1 week ago, Beau's owners noticed that Waldo needed to urinate more frequently, and was straining when urinating. He seemed to be in pain. They observed a red-orange tint to his urine. Yesterday, Waldo began vomiting often.

**Diagnosis:**

**Patient #3:**

**Name:** Mr. Whiskers **Species:** Cat **Breed:** DSH **Age:** 2 **Sex:** F **Weight:** 9 lb.

**Patient Symptoms:** About 6 months ago, Whiskers was spayed at this office. About 2 weeks ago, Mr. Whiskers' owners noticed that she was frequently urinating in the bathtub. This urine had a red-orange tint to it, but seemed a bit thick and cloudy.

**Diagnosis:**

**Patient #4:**

**Name:** Homer **Species:** Dog **Breed:** Pug **Age:** 6 **Sex:** M **Weight:** 15 lb.

**Patient Symptoms:** Homer is in for his yearly check-up. Homer's owners have noticed that Homer seems to be gaining weight and has been drinking a little more than usual.

**Diagnosis:**

Note for teachers:

- Create Urine Samples:
  - Patient #1: Mountain Dew
    - Diagnosis: Diabetes- high in glucose levels
  - Patient #2: Chicken Bouillon and one to two drops of beef blood
    - Diagnosis: Kidney Stone
  - Patient #3: Chicken Bouillon, Milk and one to two drops of beef blood
    - Diagnosis: UTI
  - Patient #4: Chicken Bouillon
    - Normal Sample

\*\* Extension for Urinalysis lab –

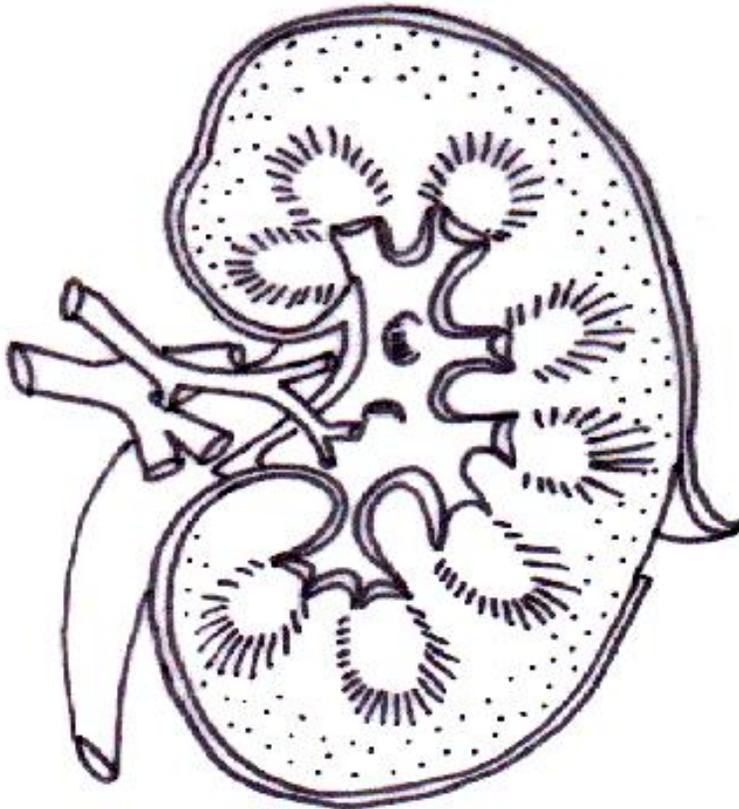
Have students determine/ research possible treatments for each scenario

**Appendix J Kidney Worksheet**

1. These are functions of the kidney: (Circle 4)

- a. breaking down damaged blood cells
- b. controlling the concentration of water in the blood
- c. Removing urea from the blood
- d. Removing carbon dioxide from the blood
- e. Removing glucose from the blood
- f. Keeping the blood at the right pH (acidity/alkalinity)
- g. Digesting food
- h. Controlling the concentration of salts like sodium and potassium chloride in the blood

2. Add the following labels to the diagram of a kidney below. Color in the diagram as indicated. :capsule- turquoise; renal artery – red; renal vein – blue; cortex - brown; medulla - pink; pelvis - yellow; ureter – green; pyramids – purple



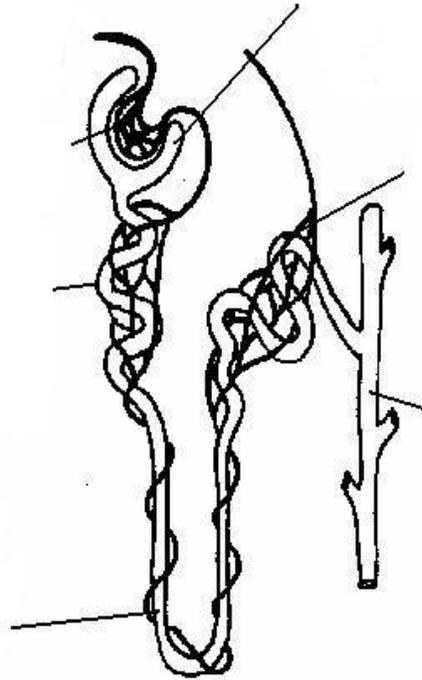
3. Match the organ with the function in the table below.

**Kidney; cortex; ureter; bladder; renal vein; urethra; capsule; medulla; renal pelvis; renal artery; sphincter**

Organ	Function
.....	Carries urine from the bladder to the outside of the body
.....	Carries deoxygenated blood away from the kidney
.....	The inner region of the kidney
.....	Muscle that opens to allow urine to be removed from bladder
.....	The outer region of the kidney
.....	Carries oxygenated blood to the kidney
.....	The part of the kidney that collects the urine before it passes down the ureter
.....	The tough fibrous coat around the kidney
.....	Stores urine before it is removed from body
.....	The tube that carries urine away from the kidney
.....	Converts blood to urine

4. Add the following labels to the diagram below of a kidney tubule or nephron.

**collecting duct; branch of renal artery; loop of Henle; distal convoluted tubule;  
glomerulus; proximal convoluted tubule; Bowman's capsule**



5. Match the part of the kidney tubule with its function.

**collecting duct; loop of Henle; distal convoluted tubule; glomerulus; proximal convoluted tubule; renal artery; Bowman's capsule; Antidiuretic hormone or ADH.**

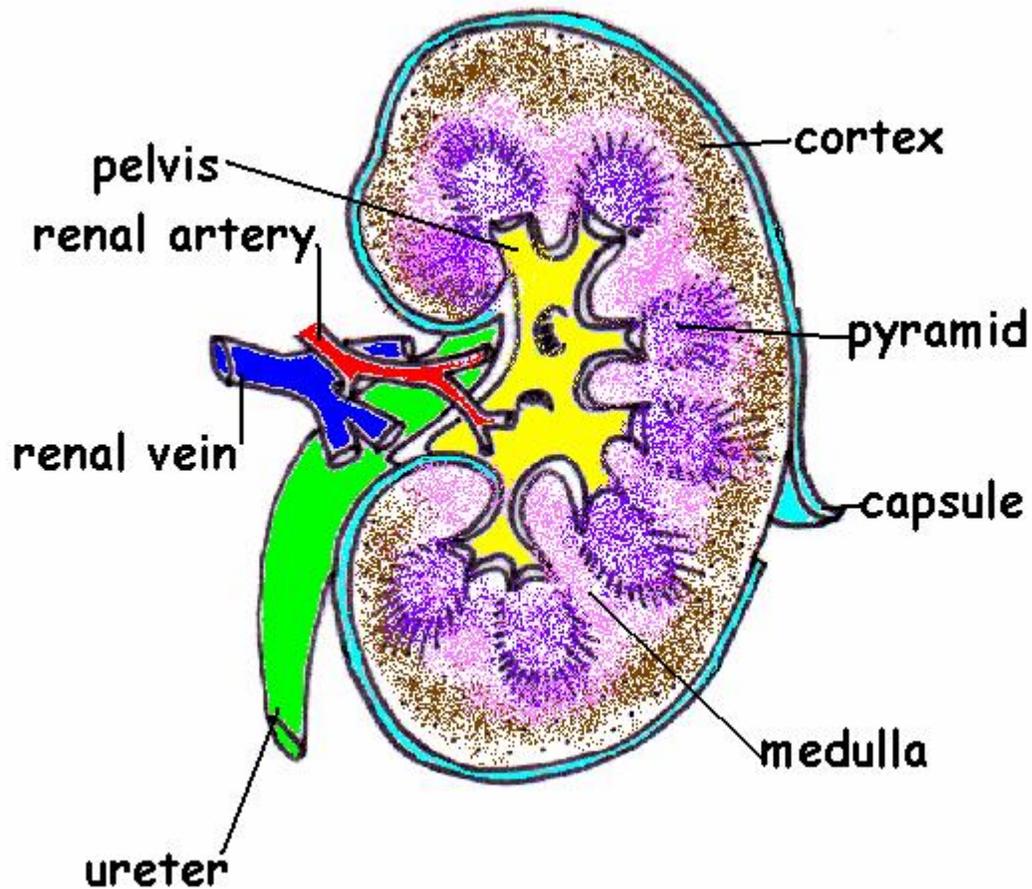
Part of tubule	Function
.....	Carries blood to the kidney
.....	The hormone that is involved in producing concentrated urine
.....	Cup shaped structure through which the fluid part of the blood is filtered
.....	Where the majority of water is extracted from the urine
.....	Looped portion of the tubule. Important for helping concentrate the urine
.....	Where hydrogen and potassium ions are secreted into the urine
.....	Glucose, salts, water and amino acids are reabsorbed into the blood capillaries here
.....	Tuft of capillaries carrying high pressure blood

**Kidney Worksheet KEY**

1. These are functions of the kidney: (Circle 4)

- b. *Controlling the concentration of water in the blood*
- c. *Removing urea from the blood*
- f. *Keeping the blood at the right pH (acidity/alkalinity)*
- h. *Controlling the concentration of salts like sodium and potassium chloride in the blood*

2. Add the following labels to the diagram of a kidney below. If you like you can also color in the diagram as indicated. :capsule- turquoise; renal artery – red; renal vein – blue; cortex - brown; medulla - pink; pelvis - yellow; ureter – green; pyramids - purple

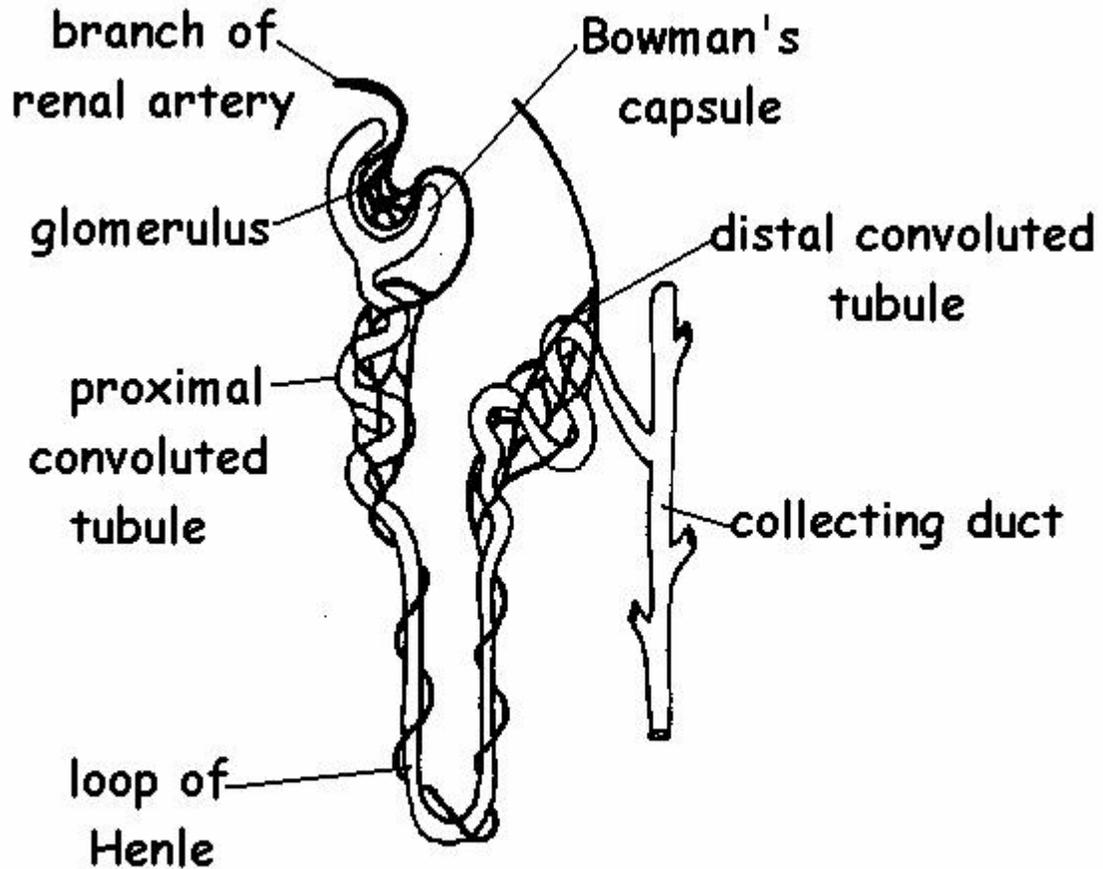


3. Match the organ with the function in the table below.

<b>Organ</b>	<b>Function</b>
<i>Urethra</i>	Carries urine from the bladder to the outside of the body
<i>Renal vein</i>	Carries deoxygenated blood away from the kidney
<i>Medulla</i>	The inner region of the kidney
<i>Sphincter</i>	Muscle that opens to allow urine to be removed from bladder
<i>Cortex</i>	The outer region of the kidney
<i>Renal artery</i>	Carries oxygenated blood to the kidney
<i>Renal pelvis</i>	The part of the kidney that collects the urine before it passes down the ureter
<i>Capsule</i>	The tough fibrous coat around the kidney
<i>Bladder</i>	Stores urine before it is removed from body
<i>Ureter</i>	The tube that carries urine away from the kidney
<i>Kidney</i>	Converts blood to urine

4. Add the following labels to the diagram below of a kidney tubule or nephron.

**collecting duct; branch of renal artery; loop of Henle; distal convoluted tubule;  
glomerulus; proximal convoluted tubule; Bowman's capsule**



5. Match the term with its function.

<b>Term</b>	<b>Function</b>
<i>Renal artery</i>	Carries blood to the kidney
<i>Antidiuretic hormone or ADH</i>	The hormone that is involved in producing concentrated urine
<i>Bowman's capsule</i>	Cup shaped structure through which the fluid part of the blood is filtered
<i>Collecting duct</i>	Where the majority of water is extracted from the urine
<i>Loop of Henle</i>	Looped portion of the tubule. Important for helping concentrate the urine
<i>Distal convoluted tubule</i>	Where hydrogen and potassium ions are secreted into the urine
<i>Proximal convoluted tubule</i>	Glucose, salts, water and amino acids are reabsorbed into the blood capillaries here
<i>Glomerulus</i>	Tuft of capillaries carrying high pressure blood



- Use pins and the labels provided to make small flags to indicate the following structures:
  - Renal capsule
  - cortex
  - medulla
  - renal callacys
  - calyx
  - ureter
  - adipose tissue
  - pyram

***Make observations and answer Questions 5 and 6 below:***

### Questions

5. Name the equipment used for the dissection

---

---

---

6. What is the color of the:

- a) Cortex? \_\_\_\_\_
- b) Medulla? \_\_\_\_\_
- c) Pelvis? \_\_\_\_\_

- *Draw a life-size diagram of the longitudinal section through the kidney on another piece of paper and include labels and a heading.*
- Dispose of the kidney and gloves as instructed, clean all the equipment, the bench and work area, and wash hands.

**Rubric**

<b>CRITERIA</b>	<b>Possible Points</b>	<b>Points earned</b>
Dissection: External structure of the kidney	1	
Life-size sketch including heading and 4 specified labels	5	
Dissection: Longitudinal section through the kidney	1	
Accurate Flag Labels	8	
Life size sketch including heading and labels	1	
Questions	14	
<b>Total</b>	<b>30</b>	

**FLAGS:**

<b>RENAL CAPSULE</b>	<b>ADIPOSE TISSUE</b>	<b>CORTEX</b>	<b>MEDULLA</b>
<b>URETER</b>	<b>RENAL PELVIS</b>	<b>PYRAMID</b>	<b>CALLACYS</b>

**Appendix L – Kidney Infiltration Lab**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**KIDNEY INFILTRATION LAB****Notes**

Objectives: At the end of this lab, you will be able to:

- Determine how kidneys function
- Identify components of the blood that should be removed by the kidneys
- Identify components of blood that should not be present in the urine

**Materials Needed**

- 1 Cup
- 1 piece of mesh
- Water
- 1 spoon
- “Components of Blood Bead Bag”

Large Beads (will not pass through screen)	12mm transparent red faceted beads(simulates red blood cells)	3-4 beads
	15mm white berry beads, (simulates white blood cells)	3-4 beads
	12mm transparent green starflakes, simulates protein)	3-4 beads
Small Beads (will pass through screen)	4mm white faceted bead, (simulates salt)	15-20 beads
	4mm green faceted bead, (simulates amino acids)	15-20 beads
	4mm dark sapphire faceted bead, (simulates glucose)	15-20 beads
	4mm yellow faceted bead, (simulates urine)	15-20 beads

Helpful website to reinforce/practice- <http://www.biologymad.com/resources/kidney.swf>**What Do Kidneys Do?**

- Maintain \_\_\_\_\_
- Remove \_\_\_\_\_ and other waste
- Regulate the amount of \_\_\_\_\_ in the blood
- Adjust the \_\_\_\_\_ of other substances in the blood
- Send \_\_\_\_\_ blood back throughout the body

**Blood Components**

- The following items are found in the bloodstream:
  - Water
  - Red Blood Cells
  - White Blood Cells
  - Glucose
  - Protein
  - Amino Acids
  - Salt
  - Urea

- As blood goes through the kidneys, some components of blood are
  - Kept: because they are \_\_\_\_\_ for life functions
  - Removed: and \_\_\_\_\_ in the urine because they are \_\_\_\_\_
  - Balanced: so they are present in the correct \_\_\_\_\_ in the blood
    - ✦ \_\_\_\_\_ reabsorbed ( \_\_\_\_\_ them all)
    - ✦ \_\_\_\_\_ reabsorbed ( \_\_\_\_\_ a certain amount as needed)
- Blood Components And Action Taken

<b>Blood Component</b>	<b>Action Taken By Kidneys</b>
Water	
Red Blood Cells	
White Blood Cells	
Glucose	
Protein	
Amino Acids	
Salt	
Urea	

### **How Kidneys Work**

- Blood enters the kidneys through the \_\_\_\_\_
- Blood branches out to small capillaries (called \_\_\_\_\_)
- Big particles stay in the blood
  - Red Blood Cells
  - White Blood Cells
  - Proteins
- Small particles go into a holding area (called the \_\_\_\_\_)
  - The material in the nephron is called \_\_\_\_\_
- The body \_\_\_\_\_ some (selectively) or all (completely) of the materials required for homeostasis
- The remaining filtrate is sent to the bladder as \_\_\_\_\_

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**KIDNEY INFILTRATION LAB**  
**Lab Worksheet**

Step 1: Blood Enters the Kidney through the \_\_\_\_\_

- Remove the bag labeled “Components of Blood”
- Using the following key, identify how many of each of the components of blood you have (please note that blood components change based on animal health and nutrition)

<u>Component</u>	<u># Present</u>
Red Blood Cells	
White Blood Cells	
Proteins	
Amino Acids	
Glucose	
Salt	
Urea	

<b>KEY</b>	
Large Beads	Red = red blood cells
	White = white blood cells
	Green = proteins
Small Beads	Green = amino acids
	Blue = glucose
	White = salt
	Yellow = urea

- Add the contents of the bag labeled “Blood Components” to the cup labeled “Blood in the Renal Artery Entering the Kidney.”
- Blood also contains water. Add enough water to fill the cup containing the beads about three quarters full of water.
- What five blood components should be **kept** in the blood as they pass through the kidney? \_\_\_\_\_  
What type of bead represents each of these components?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

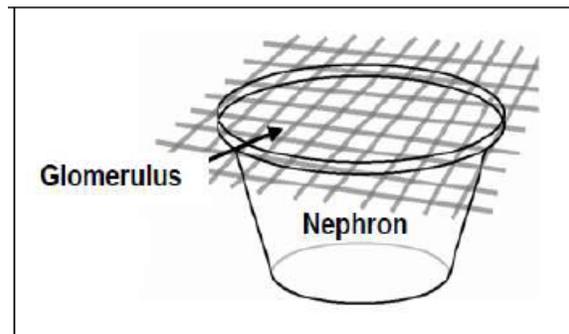
- What blood component should be balanced? \_\_\_\_\_

- What three substances would you expect to find in urine that is **excreted** by the kidney?
- 

Step 2: The renal arteries branch to supply blood to the tiny balls of capillaries called \_\_\_\_\_ which filter blood to holding areas called \_\_\_\_\_

- Prepare a simulated glomerulus and nephron: take a cup and label it “nephron”, stretch a piece of mesh TIGHTLY over the cup and secure it with a rubber band. The mesh is the thin wall of the capillary or glomerulus
- Pour the contents of the blood in renal artery cup through the glomerulus into the nephron.
- What is the material collected in the nephron called \_\_\_\_\_?
- The materials trapped on top of the screen remain in the blood. Pour the materials that stay on top of the screen into the cup labeled “Blood in Renal Vein.” Note: some of the small beads may remain on top of the screen. This is OK. In fact, this actually occurs in the kidneys. Most, but not all, of the substances leave the blood.

- Write the names of the three blood components that are kept in the blood because they are too large to pass through the pores of the glomerulus. (See key on page one of the lab.)



- The substances that pass through the screen and into the nephron form a fluid called the filtrate. What five substances form the filtrate?
- 

- Does the process of filtration alone completely separate the wastes from the essential materials? Support your answer with observations of what is present in the nephron cup.
- 
- 

### Step 3: Kidneys Reabsorb Needed Substances

#### Complete Reabsorption.

Some essential molecules, such as glucose and amino acids, are kept by being completely reabsorbed. These molecules should be completely returned to the blood and should not end up

in the urine produced by the kidney. The kidneys use energy to transport these molecules back into the blood.

- What two substances in the filtrate are essential and need to be completely reabsorbed?
- 

- Model the complete reabsorption of these substances. Use the spoons to move ALL of the completely reabsorbed substances from the “Nephron” cup to the “Blood in Renal Vein” cup.

### Selective Reabsorption

Other molecules, such as water and salt, are balanced by being selectively reabsorbed to maintain the proper salt and water balance in the body. Their reabsorption is regulated so that they are returned to the blood if needed but are excreted in the urine if present in excess amounts.

Specific transport proteins in the nephron use energy to move these molecules from the nephron into the capillaries that surround the nephron.

- What two substances should be balanced by being selectively reabsorbed?
- 

- Use the spoon to collect 5 white salt beads and place them in the “Blood in Renal Vein” cup. Leave the remaining (excess) salt in the “Nephron” so it can be excreted.

- How many white beads are left over so that they can be excreted?
- 

Step 4: The kidney returns filtered blood to the body

- The “Blood in the Renal Vein” cup contains “clean” blood.
  - After reabsorption has occurred, what seven substances are present in the “clean” blood in the renal vein?
- 
- 

- What do you think happens to the “clean” blood in the renal vein?
-

**Kidney Infiltration Lab KEY**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**KIDNEY INFILTRATION LAB**

**Notes**

Objectives: At the end of this lab, you will be able to:

- Determine how kidneys function
- Identify components of the blood that should be removed by the kidneys
- Identify components of blood that should not be present in the urine

**Materials Needed**

- 1 Cup
- 1 piece of mesh
- Water
- 1 spoon
- “Components of Blood Bead Bag”

Large Beads (will not pass through screen)	12mm transparent red faceted beads(simulates red blood cells)	3-4 beads
	15mm white berry beads, (simulates white blood cells)	3-4 beads
	12mm transparent green starflakes, simulates protein)	3-4 beads
Small Beads (will pass through screen)	4mm white faceted bead, (simulates salt)	15-20 beads
	4mm green faceted bead, (simulates amino acids)	15-20 beads
	4mm dark sapphire faceted bead, (simulates glucose)	15-20 beads
	4mm yellow faceted bead, (simulates urine)	15-20 beads

Helpful website to reinforce/practice- <http://www.biologymad.com/resources/kidney.swf>

**What Do Kidneys Do?**

- Maintain Homeostasis
- Remove Urea and other waste
- Regulate the amount of Water in the blood
- Adjust the concentration of other substances in the blood
- Send Clean blood back throughout the body

**Blood Components**

- The following items are found in the bloodstream:
  - Water
  - Red Blood Cells
  - White Blood Cells
  - Glucose
  - Protein
  - Amino Acids
  - Salt
  - Urea

- As blood goes through the kidneys, some components of blood are
  - Kept: because they are essential for life functions
  - Removed: and Excreted in the urine because they are toxic (poisonous)
  - Balanced: so they are present in the correct concentration in the blood
    - ✦ Water reabsorbed (essential them all)
    - ✦ Salt reabsorbed (excess excreted in urine a certain amount as needed)
- Blood Components And Action Taken

<u>Blood Component</u>	<u>Action Taken By Kidneys</u>
Water	Reabsorb ( kept)
Red Blood Cells	Reused ( kept)
White Blood Cells	Reused ( kept)
Glucose	Reused ( kept) completely reabsorbed
Protein	Used ( kept)
Amino Acids	Used ( kept) completely reabsorbed
Salt	Used ( kept)
Urea	Excreted

### How Kidneys Work

- Blood enters the kidneys through the renal arteries
- Blood branches out to small capillaries (called glomeruli )
- Big particles stay in the blood
  - Red Blood Cells
  - White Blood Cells
  - Proteins
- Small particles go into a holding area (called the nephron )
  - The material in the nephron is called filtrate
- The body keeps some (selectively) or all (completely) of the materials required for homeostasis = Balance
- The remaining filtrate is sent to the bladder as urine
  - Salt and water are selectively reabsorbed

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**KIDNEY INFILTRATION LAB**  
**Lab Worksheet KEY**

Step 1: Blood Enters the Kidney through the Renal Artery

- Remove the bag labeled “Components of Blood”
- Using the following key, identify how many of each of the components of blood you have (please note that blood components change based on animal health and nutrition)

<u>Component</u>	<u># Present</u>
Red Blood Cells	
White Blood Cells	
Proteins	
Amino Acids	
Glucose	
Salt	
Urea	

<b>KEY</b>	
Large Beads	Red = red blood cells
	White = white blood cells
	Green = proteins
Small Beads	Green = amino acids
	Blue = glucose
	White = salt
	Yellow = urea

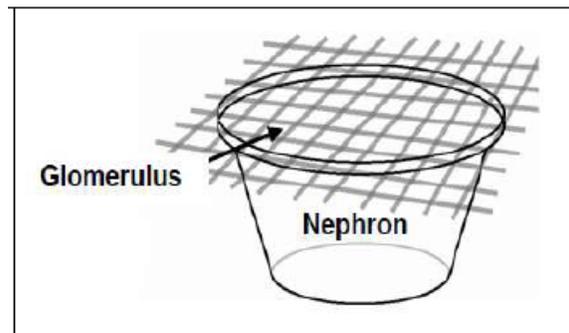
- Add the contents of the bag labeled “Blood Components” to the cup labeled “Blood in the Renal Artery Entering the Kidney.”
- Blood also contains water. Add enough water to fill the cup containing the beads about three quarters full of water.
- What five blood components should be **kept** in the blood as they pass through the kidney? RBC, WBC, proteins, amino acids, glucose  
What type of bead represents each of these components?  
RBC large red beads  
WBC Large white beads  
Proteins large green beans  
Amino acids small blue beads  
Glucose small blue beads
- What blood component should be balanced? Salt small white beads

- What three substances would you expect to find in urine that is **excreted** by the kidney? Water, salt, urea

Step 2: The renal arteries branch to supply blood to the tiny balls of capillaries called glomerulus which filter blood to holding areas called Nephron

- Prepare a simulated glomerulus and nephron: take a cup and label it “nephron”, stretch a piece of mesh TIGHTLY over the cup and secure it with a rubber band. The mesh is the thin wall of the capillary or glomerulus
- Pour the contents of the blood in renal artery cup through the glomerulus into the nephron.
- What is the material collected in the nephron called filtrate ?
- The materials trapped on top of the screen remain in the blood. Pour the materials that stay on top of the screen into the cup labeled “Blood in Renal Vein.” Note: some of the small beads may remain on top of the screen. This is OK. In fact, this actually occurs in the kidneys. Most, but not all, of the substances leave the blood.

- Write the names of the three blood components that are kept in the blood because they are too large to pass through the pores of the glomerulus. (See key on page one of the lab.)



RBC, WBC, proteins

- The substances that pass through the screen and into the nephron form a fluid called the filtrate. What five substances form the filtrate?

Amino acids, glucose, water, salt, urea

- Does the process of filtration alone completely separate the wastes from the essential materials? Support your answer with observations of what is present in the nephron cup.

No – the filtrate in the nephron cup contains wastes ( urea) and essential materials ( glucose, amino acids and water)

Step 3: Kidneys Reabsorb Needed Substances

Complete Reabsorption.

Some essential molecules, such as glucose and amino acids, are kept by being completely reabsorbed. These molecules should be completely returned to the blood and should not end up in the urine produced by the kidney. The kidneys use energy to transport these molecules back into the blood.

- What two substances in the filtrate are essential and need to be completely reabsorbed? Glucose and amino acid
- Model the complete reabsorption of these substances. Use the spoons to move ALL of the completely reabsorbed substances from the “Nephron” cup to the “Blood in Renal Vein” cup.

### Selective Reabsorption

Other molecules, such as water and salt, are balanced by being selectively reabsorbed to maintain the proper salt and water balance in the body. Their reabsorption is regulated so that they are returned to the blood if needed but are excreted in the urine if present in excess amounts. Specific transport proteins in the nephron use energy to move these molecules from the nephron into the capillaries that surround the nephron.

- What two substances should be balanced by being selectively reabsorbed?  
Salt and water
- Use the spoon to collect 5 white salt beads and place them in the “Blood in Renal Vein” cup. Leave the remaining (excess) salt in the “Nephron” so it can be excreted.
- How many white beads are left over so that they can be excreted?  
Varies per student represents homeostasis

Step 4: The kidney returns filtered blood to the body

- The “Blood in the Renal Vein” cup contains “clean” blood.
- After reabsorption has occurred, what seven substances are present in the “clean” blood in the renal vein?

Water, RBC, WBC, protein, glucose, amino acids and salt

- What do you think happens to the “clean” blood in the renal vein?  
would return to the heart to be recirculated to all parts of the body

**Appendix M Evaluation Forms for Activities****One Evaluation form was provided per Activity**

	Strongly Disagree	Disagree Somewhat	Neutral	Somewhat Agree	Strongly Agree
The content of the activity targets specified standards.					
The content of the activity provided depth of the concept for specified standards.					
The activity structure was logical and coherent.					
The activity provided hands-on learning opportunities for students.					
The teacher could use the activity as presented with little or no alterations.					

Please provide specifics on which aspects of the activity worked best.

Please provide specifics on which aspects need to be improved for this activity.

**Overall evaluation for Circulatory System Activities**

	Strongly Disagree	Disagree Somewhat	Neutral	Somewhat Agree	Strongly Agree
The objectives of the curriculum were met successfully.					
The content of the curriculum provided depth of the specified concept.					
The curriculum structure was logical and coherent					
The teacher could use the curriculum as presented with little or no alterations.					

Please provide specifics on which aspects of the curriculum worked best.

Please provide specifics on which aspects need to be improved for this curriculum.