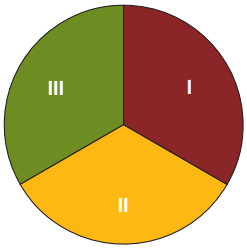
Life Sciences: Pedagogy (0234)

Test at a Glance

Test Name	**Life Sciences: Pedagogy**
Test Code	**0234**
Time	**1 hour**
Number of Questions	**1 three-part essay question**
Format	**Exercises pose questions requiring written responses in English**



Content Categories		Approximate Number of Questions	Approximate Percentage of Examination
I.	Content and Rationale	1	33.3%
II.	Instructional Strategies	1	33.3%
III.	Assessment	1	33.3%

About This Test

The Life Sciences: Pedagogy test is designed to measure the subject-area knowledge and competencies necessary for a beginning teacher of biology in a secondary school.

Examinees are given a topic for a one-week unit for a high school biology course, followed by a three-part question. Examinees are asked to formulate and rationalize learning objectives for the topic. Examinees are then asked to describe instructional strategies appropriate for helping students achieve the specific learning objectives, including elements of inquiry-based learning. Finally, examinees are asked to describe methods that can be used to assess student mastery of the specific learning objectives. The unit topic is drawn from the following content areas: basic principles of science; molecular and cellular biology; classical genetics and evolution; diversity of life, plants, and animals; ecology; and science, technology, and society. (For a description of these content areas, see the Biology: Content Knowledge, Part 1, Test [0231].)

Sample Test Questions

This section presents a sample question and sample responses, along with the standards used in scoring the essay. When you read these sample responses, keep in mind that they will be less polished than if they had been developed at home, edited, and carefully presented. The examinee does not know what science concept will be assessed and must decide, on the spot, how to respond. Readers take these circumstances into account when scoring the responses. Each of the three parts of the responses are weighted equally, and will be scored on a scale of 0–5, resulting in a total score of 0–15.

Readers will assign scores to each part of the response based on the following scoring guide.

SCORING GUIDE

5

- Demonstrates a superior understanding of how to teach the science concepts required by the question
  - Part 1:
    - identifies three distinct and significant learning objectives that are clearly relevant to the unit presented
    - provides clear, well-reasoned explanations of why each objective is important
  - Part 2:
    - gives a fully detailed description of instructional strategies likely to help students meet the three objectives including a strong description of an inquiry-based activity
  - Part 3:
    - gives a fully detailed description of two methods of assessment
    - clearly justifies why the assessments would be effective in determining student mastery of the three objectives
- Uses accurate scientific terminology throughout

4

- Demonstrates a strong understanding of how to teach the science concepts required by the question
  - Part 1:
    - identifies three distinct learning objectives that are relevant to the unit presented
    - provides clear and logical explanations of why each objective is important
  - Part 2:
    - gives a detailed description of instructional strategies likely to help students meet the three objectives, including a developed, inquiry-based activity
  - Part 3:
    - gives a detailed description of two methods of assessment
    - justifies why the assessments would be effective in determining student mastery of the three objectives
- Uses accurate scientific terminology

3

- Demonstrates an adequate understanding of how to teach the science concepts required by the question
  - Part 1:
    - identifies three distinct learning objectives that are generally relevant to the unit presented
    - provides generally clear explanations of why each objective is important
  - Part 2:
    - gives a fairly detailed description of instructional strategies likely to help students meet the objectives, including a developed, inquiry-based activity
  - Part 3:
    - gives a fairly detailed description of two methods of assessment
    - sufficiently justifies why the assessments would be effective in determining student mastery of two or three objectives
- Uses some accurate scientific terminology

2

- Demonstrates a limited understanding of how to teach the science concepts required by the question
  - Part 1:
    - fails to identify three distinct learning objectives
    - gives limited explanations of why the objectives are important
  - Part 2:
    - gives a limited description of instructional strategies
  - Part 3:
    - gives a poor or incomplete description of two methods of assessment
    - does not clearly justify why the methods of assessment would be effective in determining student mastery of the objectives
- Lacks accurate scientific terminology

1

- Demonstrates very little understanding of how to teach the science concepts required by the question
  Part 1:
  – fails to identify three learning objectives
  – gives little or no explanation of why the objectives are important
  Part 2:
  – gives little or no description of instructional strategies
  Part 3:
  – gives little or no description of methods of assessment
  – does not justify why the methods of assessment would be effective in determining student mastery of the objectives
- Fails to use accurate scientific terminology

0

- Completely inaccurate or inappropriate, blank, or off topic

Sample Question

You will be teaching a one-week unit on vertebrate circulatory systems for a first-year high school biology course. Assume that your class meets five times a week, including four 45-minute sessions and one 90-minute session. Based on this information, provide detailed responses to all sections of the following three parts.

Part 1–Content and Rationale

Discuss each of the following:

- State three significant learning objectives for the unit on vertebrate circulatory systems that you would like your students to achieve. These should be major concepts crucial to an understanding of this unit and appropriate for a high school biology course.
- Explain why it is important to concentrate on each of these objectives.
- Describe the main ideas and skills you would expect students to learn.

Part 2–Instructional Strategies

- Describe in detail the various instructional strategies you would use during the week to help your students achieve the three learning objectives. Include elements of inquiry-based learning in these strategies.

Part 3–Assessment

Discuss each of the following:

- Describe in detail two distinct methods of assessment (excluding multiple-choice) that are appropriate to use as an end-of-unit evaluation to measure how well your students have achieved the three learning objectives.
- Describe specific examples of acceptable projects and/or responses you would expect from the students and the criteria you would use in evaluating them.
- Explain how each of these methods of assessment will provide information about student knowledge and skills.

Sample Response That Received a Total Score of 12:

Part 1

Three learning objectives for the unit entitled "Vertebrate Circulatory System" would include 1) describe and be able to identify the major structures in an amphibian, reptilian, and mammalian heart, 2) describe the normal pathway of blood as it travels from the heart through the human body and back to the heart and understand how abnormalities and disease states occur, 3) list the major nutrients and gases that are exchanged within the capillary beds and describe how this exchange occurs.

These objectives are important for several different reasons. First of all, the different morphologies of different animals' hearts are important in a unit of vertebrate circulatory systems. The different hearts are all able to perform the same complex task of bathing the body in oxygen gas and removing poisonous carbon dioxide, even though their relative heart size, chamber number, and general morphology differ. Students need to understand that not all hearts are alike and that mechanisms of circulation have evolved to meet individual animal needs. Objective two is important for several reasons. First, it elaborates on the complexity of the circulatory system and gives students a greater appreciation for the intricate details involved. It also familiarizes students with various anatomical structures and their functions within the system. [A discussion of structural differences between arteries and veins highlights the need for different types of blood vessels. Understanding the circulatory pathway can also provide students with insights into the cause of some of the more common coronary diseases. A brief discussion of what a healthy heart is and how coronary artery disease and atherosclerosis occur provides a practical application of the knowledge which most students enjoy.] Objective three emphasizes the complex physiological processes occurring within the capillary beds and strengthens students' understanding of metabolite exchange occurring throughout the body.

By the end of this unit, I would expect students to identify and understand differences in structures between the different vertebrate hearts we examined. For example, students should know that a fish heart has 2 chambers, an amphibian heart has 3 chambers, and the mammalian heart has 4. Students should understand single and double circulation mechanisms and why fish utilize single circulation while amphibians and mammals utilize double circulation. Student should know the normal flow of blood through the human body (right ventricle, left lung, left atrium, left ventricle, etc.) and how that flow is altered in a disease state such as atherosclerosis and hypertension. The students should also understand the components and basic mechanism of gas and metabolite exchange through the circulatory system, how oxygen and carbon dioxide are exchanged by diffusion at the capillary vessels.

Part 2

Several strategies should be incorporated to meet these three objectives. First of all, lecture is an invaluable tool. Two 45-minute periods would be appropriate for lectures on the morphology of various animal hearts, a description of pathways of blood through the body, and an elaboration on the exchange of nutrients and gases between blood and tissue at the capillary beds. Following lecture, web-based instruction can also be used to help the students visualize what was taught. There are several "virtual heart" sites that help students visualize the anatomy and physiology of what is going on in the mammalian heart and that show the flow of blood and exchange at the capillaries. A third lecture can be spent discussing the disease states and associated physiology. Students will learn about normal blood pressure and heart rate values and how clogged arteries can alter these. Students would be asked to predict the effects of exercise or activity on these parameters. A demonstration using a blood pressure cuff and stethoscope would then be very useful. Student volunteers could undergo short bursts of activity (running up stairs or slow walking) and their heart rate and blood pressure monitored before, immediately after, and following a recovery period. Comparisons to the students' original prediction would be made. Then, what occurs during heart disease and atherosclerosis could be compared directly to the changes they observed in the healthy student volunteers.

The 90-minute period would best be used in a dissection laboratory exercise. Models of a fish heart, a frog's heart, and a human heart could be easily obtained from any biological supply company. Initially students would be allowed to examine these models to note the differences in chamber number and size. Students will see that the fish heart has 2 chambers, the frog's heart has 3 chambers, and the human heart has 4. Then, students would be asked to dissect a sheep's heart. Initially, the instructor would demonstrate basic dissection techniques and show the students how to get started. The students would be given handouts diagramming the structures they need to identify and then be allowed to dissect the heart on their own or in teams. They would have to record the structures they identified on their handouts. Major anatomical features such as the aorta, right and left atrium, right and left ventricle, the

vena cavas and, if possible, the valves could be identified. Students would be asked to use probes to follow the flow of blood through the heart chambers. The instructor would be available for assistance but the dissection would be the primary responsibility of the students. This hands-on experience would familiarize students with basic heart structures as well as improve dissecting abilities.

Part 3

After presenting the materials to the students and allowing them to familiarize themselves through laboratory examination and dissection with several vertebrate hearts, students should be assessed for their comprehension of the material. One form of assessment would be a laboratory test where the instructor would dissect and number important components of several vertebrate hearts. For instance, the superior vena cava would have a pin inserted into it and a piece of paper reading "1". Students would identify the structure correlating to "1" on their own paper. Other major structural features that the student would need to identify could include: pulmonary veins, pulmonary arteries, left and right atria, left and right ventricles, aorta, etc. Along with identifying the structures, students will be asked to answer questions on the function of the particular structures and will need to know if the blood in the structure is oxygenated or deoxygenated. For example, after identifying the pulmonary artery from the dissected heart, the student would need to know that this structure pumps deoxygenated blood to the lungs, and that the pulmonary vein pumps oxygenated blood to the heart. In addition, students must be able to identify the type of vertebrate heart that has been dissected and cite reasons for their choice. If the heart is a sheep's heart, they should note its large size and the 4 chambers as means of identification. These structure/function types of questions are an excellent method of determining if the student really understands the circulatory system and will assess mastery of objectives 1 and 2.

A second useful method of assessment would be an essay exam. In order to assess mastery of objective 3, students should be asked to describe in detail the process of gas exchange at the capillaries and should be able to identify the major nutrients that are carried in blood. In a well-constructed essay, the student's answer should include a description of how the networks of capillaries (tiny vessels with very thin walls) infiltrate tissues and which major arteries lead into them. The student answer should also include discussion of how oxygen, carbon dioxide, and small molecules diffuse across the capillary walls due to differences in concentration and under high pressure (blood pressure). The students should know that glucose, amino acids, and fats are major nutrients transported in the blood. An essay exam such as this is a comprehensive method for assessing whether the students truly understand the content in objective 3.

Sample Response That Received a Total Score of 6:

My three learning objectives would read as follows:

1. Given a fetal pig, the 10th grade biology student will correctly identify labeled anatomical structures of the circulatory system with at least 80% accuracy.
2. Given a diagram of the heart and the circulatory system, the 10th grade biology student will correctly describe the steps of the blood flow pathway.
3. Given circulatory system vocabulary terms, the 10th grade student will be able to define/explain the significance of each.

I feel it is important to concentrate on each of these objectives because not only do they all tie together, but if a student had a solid understanding of the anatomy, blood flow, and what goes on during the flow, he/she would be able to apply this concept to other circulatory systems.

For objective 1, I would want to teach the class the anatomic structures of the circulatory system. For this I would use models of the heart (with removable parts to show the chambers), human torso models, and have laboratory exercises with fetal pigs. In combination with the above, I would use discussion formats and some lecture where the text may be utilized.

For objective 2, I would use the models listed above and also charts and diagrams of the pathway of blood. Again, discussion and lecture would be incorporated as well.

For objective 3, since it is mainly vocabulary, I would use discussion/lecture combined with diagrams/sketches of structures and their function. For example, when explaining the significance of the arterioles, venules, and exchanges within the capillary beds, I would use drawings illustrating the exchanges to support my definitions.

For objective 1, the students would be assessed by having them identify (by writing their responses on paper) pre-labeled anatomical structures of the circulatory system. Thus, this form of assessment would be hands-on.

For objective 2, the students would be given a diagram of the heart and circulatory system in which they would write out the path in which the blood travels. Objective 3 would be assessed by having the students define and tell the significance of specific vocabulary terms. Thus, the form of assessment for objectives 2 and 3 would be essay/short answer.

I feel by using these 2 forms of assessment, both concrete operational learners and formal operational learners will be capable of relating to the two methods. While the hands-on method is more concrete, the essay/short answer method requires a combination of both concrete and formal thought.

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