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A plan to assess student learning in a University General Education Core Curriculum course: BIOL1584, Biology for Majors.

WHAT UNIVERSITY GENERAL EDUCATION OUTCOMES GUIDE STUDENT LEARNING IN COURSES THAT CARRY NATURAL SCIENCES CREDIT?

A primary goal of these courses is to develop an appreciation of the basic principles that govern natural phenomena and the role of experiment and observation in revealing these principles. Students should acquire an understanding of the relationship between hypothesis, experiment, and theory, and develop the skills common to scientific inquiry, including the ability to frame hypotheses and defend conclusions based on the analysis of data. These courses are designed to prepare a student for informed citizenship by illustrating the importance of science and technology to the present and future quality of life and the ethical questions raised by scientific and technological advances.

Upon completion of eight hours of science courses, students will:

- NSLO1a - Understand how scientific inquiry is performed.
- NSLO2a - Understand the boundaries of scientific data.
- NSLO3a - Have a basic working knowledge of a few areas of science.
- NSLO4a - Be able to make better-informed decisions regarding potential government policies that involve science.
- NSLO5a - Have improved problem solving skills.
- NSLO6a - Be able to identify challenges created by society's increasing reliance upon technology.

HOW DOES THE DEPARTMENT OF BIOLOGICAL SCIENCES INTEND TO ASSESS STUDENT LEARNING OF THESE OUTCOMES IN BIOL1524?

BIOL1584 (Biology for Majors) is a lecture and laboratory course for individuals seeking a B.A. or B.S degree in Biology, or individuals with a strong interest in a more in depth knowledge of Biological Sciences. The assessment consists of a pre-test given early in the semester followed by a post-test near the end of the semester. Assessment exam includes 12 questions or statements with multiple potential responses to each question and the student must evaluate the validity or correctness of each response to the question. These questions were developed and agreed upon by the faculty teaching BIOL1584. The questions were designed to be overarching and related to broad thematic components of the course. Analysis of student performance will be based on overall performance on the exam, not on the individual questions. The same assessment exam will be used for multiple semesters so that performance over time can be compared.

HOW IS THE ASSESSMENT INSTRUMENT KEYED TO THE UNIVERSITY GENERAL EDUCATION CORE CURRICULUM LEARNING OUTCOMES FOR THE NATURAL SCIENCES?

Biology for Majors assessment

For each of the statements below; any, all, or none of the responses listed below the question or statement may be correct. Please indicate those that are a correct response to the indicated question or statement.

A. Which of the following are present in all cells?

1. A membrane-enclosed area surrounded by cytoplasm where all or most of the cell's genome is located.
2. A system for constructing membrane-bound packages in the cytoplasm.
3. A structure that can synthesize ATP only when molecular Oxygen is present.
4. A structure that absorb light and split water into Oxygen, electrons, and protons.
5. A cell wall
6. A plasma membrane made up of a phospholipid monolayer.
7. A fluid covering that consists of lipids, proteins, and often carbohydrates.
8. Nitrogen-containing polymers that pass information from cell generation to cell generation.
9. A mechanism for extracting energy from the outside environment.
10. Phosphorus-containing polymers that pass information from cell generation to cell generation.
12. Catalytic polymers that are made from monomers that each contain a phosphate group.
13. Catalytic polymers that are made from monomers that each contain an amino group.
14. Polymers that are constructed using hydrolytic reactions.
15. Molecules that will not be passed to the next cell generation.

NSLO2a, NSLO3a, NSLO5a

B. Which of the following may apply to a multicellular organism that can photosynthesize?

16. It will only be able to get the Carbon it needs from organic compounds.
17. It may contain some cells that are autotrophic and some cells that are heterotrophic.

18. It may require the help of insects to complete its life trajectory.
19. It will participate in the part of the Carbon Cycle where Carbon Dioxide is added to the abiotic environment.
20. It will participate in the part of the Carbon Cycle where Carbon Dioxide is chemically added to organic compounds.

NSLO2a, NSLO3a, NSLO5a

C. Which of the following are generally characteristic of organisms in which mitosis occurs?

21. They have organelles that carry out the Citric Acid Cycle or they are descended from ancestors that had that kind of organelles.
22. They always have organelles that generate molecular Oxygen when they are illuminated.
23. They have a life trajectory where cells alternate between being haploid and diploid, or they are the descendants of such organisms.
24. Most such organisms have complex multicellular bodies.
25. Most such organisms have a point in their life trajectory where they consist of a single cell.
26. All of their genetic material is located on a single, circular chromosome.
27. Their cells can construct protein molecules without participation of single-stranded nucleic acids that contain the base uracil.
28. Their cells contain few or no membrane-bound components.
29. They do not need to participate in the Phosphorus Cycle.
30. They can use molecular Nitrogen from the atmosphere directly to construct Ammonia.

NSLO2a, NSLO3a, NSLO5a

D. Surface area to volume ratios are very important in Biology. Which of the following are correct statements about surface area to volume ratios?

31. A sphere will have a greater surface area than a disk that has the same volume.
32. As an object increases in size without changing shape, its surface area increases by the cube and its volume increases by the square.
33. Surface area to volume ratios require that all cells must be microscopic.
34. Surface area to volume ratios apply to the architecture of multicellular organisms as much as they do to cells.

35. Surface area to volume ratios can be used to explain why trees are tall.

NSLO1a, NSLO2a, NSLO3a, NSLO5a

E. The makeup of an organism's cells is controlled by each cell's proteome. The content of a cell's proteome at any given time is affected by several factors that involve the cell receiving information. Which of the following are examples of ways information can be transmitted to a cell or within a cell such that the proteome will be controlled?

36. A cell of a member of Archaea receives a nucleus from its ancestor.

37. An inhibitory molecule binds to an enzyme.

38. A specific protein binds to a particular stretch of DNA.

39. A portion of a DNA molecule has extra chemical groups chemically added to it.

40. A cell that was in the dark gets illuminated.

41. The temperature around a cell changes.

42. Chemicals from the environment outside the cell attach to chemicals that are part of the cell's plasma membrane.

43. A protein donates a phosphate group from ATP to another protein.

44. The supply of oxygen to a cell is greatly reduced.

45. The concentration of dissolved protons in the water outside a cell increases substantially.

NSLO1a, NSLO2a, NSLO3a, NSLO5a

F. Biogeochemical cycles are a way of looking at how particular chemicals move from the abiotic, nonliving, part of the environment to the living things in the environment and back again. Most of the biogeochemical cycles we consider follow the paths of particular elements into and out of organisms. Two of the most significant cycles we emphasize in biology are the Carbon Cycle, where we follow how Carbon from Carbon Dioxide in the environment gets incorporated into organic molecules and then gets back into Carbon Dioxide, and the Nitrogen Cycle, where Nitrogen from inorganic molecules gets incorporated into organic molecules such as amino acids and nucleotides and then gets reincorporated into inorganic molecules. The following responses concern the Carbon and Nitrogen Cycles. Some may be correct and relevant to these cycles and some may not. Indicate which responses are correct.

46. Molecular Nitrogen, N_2 , can be converted to Ammonia, NH_3 , by the Nitrogenase enzyme, an enzyme that is found in the cells of all organisms.

47. Ribulose Bisphosphate Carboxylase Oxidase (RuBisCO) is the most common enzyme for chemically adding Carbon from Carbon Dioxide to organic compounds.

48. RuBisCO is present only in the cells of organisms that we characterize as heterotrophs, aka consumers.
49. The availability of Nitrogen sources in an environment can affect the abundance of a given species of organism in that environment.
50. Organisms that cannot make either Nitrogenase or RuBisCO cannot survive in nature.
51. An organism must have an adequate supply of Nitrogen in order to make new copies of its genes.
52. Every time a cell makes a new protein, it must import enough new nitrogen from its outside environment.
53. A living organism must have an outside source of energy to participate in the Carbon Cycle and the Nitrogen Cycle.
54. RuBisCO is located in the endoplasmic reticulum of cells.
55. Organisms that contain RuBisCO are more abundant in the world than organisms that lack RuBisCO.

NSLO1a, NSLO2a, NSLO3a, NSLO4a, NSLO5a, NSLO6a

G. Genes are particular stretches along DNA molecules. A typical DNA molecule usually contains many genes along its length. Genes can be inherited from one generation to the next. Some of the following may be correct statements about DNA and genes. Indicate which are correct.

56. Every trait you have is coded for by one specific gene.
57. Each new gene is made by an enzyme that is specific for that particular gene.
58. Every gene corresponds to a particular polypeptide.
59. Some genes can be activated when an organism that contains them is exposed to light.
60. All organisms in the same species have exactly the same set of genes.
61. Alleles are different versions of the same gene.
62. The amino acid residues that make up genes all contain some Phosphorus atoms.
63. Genes are copied more accurately than any other known entity.
64. Any organism that is triploid will have three alleles of each gene.
65. The members of a pair of alleles will segregate from each other during a kind of nuclear division that occurs in a cell that starts out as diploid.

NSLO1a, NSLO2a, NSLO3a, NSLO4a, NSLO5a

H. The term population is usually used in biology to refer to all the members of a particular species in a defined area. A population will consist of a particular number of individuals at any given time, but that number can change over time. This number can change as new members enter the population and/or as they leave it. The particular individuals in a population are not constant. All of the alleles of all the genes of all the individuals in a population are a characteristic of the population at any given time. Over time, a population may split up into two or more new populations. Conversely, two or more populations may merge into one population over time. Some individuals in a population may become parents to more surviving offspring than other individuals. Given this information, indicate which of the following responses is correct.

66. In order for a population to increase in size, the sources of chemicals and the physical aspects of the surrounding environment must remain constant.
67. All of the resources available in a population's environments must decrease in availability before a population will decrease in size.
68. The amount of a resource available in an environment can decrease and the population can still increase in size.
69. An individual's success at becoming a parent is entirely due to the favorability of the alleles in its particular genome.
70. An individual's failure to become a parent may be due to some of the alleles in its particular genome.
71. The continuance of a population over a time covered by the lifetimes of many individuals cannot be affected by what is happening in populations of other species in their shared environment.
72. The size of the population of a species of consumer may be limited by the size of the population of another species of consumer in the same environment.
73. The size of the population of a species of consumer may be limited by the size of a population of a species of a producer in the same environment.
74. A population can increase in size when new individuals of the same species move into its environment from someplace else.
75. The relative frequencies of the alleles of a given gene can remain constant even if the population gets smaller over time.

NSLO1a, NSLO2a, NSLO3a, NSLO4a, NSLO5a, NSLO6a

I. The particular place along the length of a chromosome at which any of the alleles of a given gene occurs is called that gene's locus. A chromosome consists of a single DNA molecule and a complement of chromosomal proteins.

76. An organism can have two alleles of a gene if it only has one of each chromosome per cell.

77. A triploid organism has three of each chromosome per cell.
78. A population of organisms can have as many alleles of a gene as there are chromosomes with that locus in the population.
79. An allele consists of both DNA and protein.
80. Two different alleles of a gene may code for exactly the same polypeptide.

NSLO1a, NSLO2a, NSLO3a, NSLO4a, NSLO5a

J. A population of organisms can change in size from one point in time to the next either by increasing or by decreasing in number of individuals, or the number of individuals can remain constant. Assume you are monitoring some populations long enough that some of the organisms that were originally present in each population are gone (died or moved away) and some new individuals have joined (been born or moved in). Population A has increased by 40% between the starting observation and the last observation. Population B has decreased by 50%. Population C has stayed the same size. These observations tell with certainty that: (Indicate all that you can tell with certainty.)

81. All of the increase in Population A was due to more individuals being born than died.
82. Births and immigration, together, were about the same as deaths and emigration, together, in Population C.
83. The only possible explanation for no change in Population C is that one important resource was limiting the size of the population.
84. The reason Population C remained constant was that it started out as a big population.
85. One possible explanation for the decrease in Population B could be loss of access to an important resource.

NSLO1a, NSLO2a, NSLO3a, NSLO4a, NSLO5a, NSLO6a

K. Mutations in DNA that pass from one generation to the next occur at what seems like a fairly low frequency, for instance, copying errors during replications occur at a rate of about one error per one billion base pairs copied. However, since many organisms have more than one billion base pairs of DNA in their genomes, that means that each cell generation will probably inherit a mutation. In addition, mutations can occur during other parts of the cell cycle when DNA is not being replicated. This means that on the whole cell/whole organism level, it is more common for mutations to accumulate each generation than it is for offspring to be completely genetically identical to a parent. With this information, you know that: (Indicate every response that is correct).

86. Populations of organisms accumulate mutations all the time.

87. Every offspring cell will inherit every mutation that occurred in the parent cell.
88. At least one of the assumptions of the Hardy-Weinberg model is always violated.
89. Evolution, as considered under the test of Hardy-Weinberg, cannot not occur.
90. New mutations always are subject to the action of Natural Selection.
91. New mutations will always result in the production of a modified protein that the ancestor was not able to make.
92. An offspring that inherits a mutation will always do worse in the environment than an offspring that does not inherit the mutation.
93. A new mutation established a new allele.
94. In an organism with a genome that consists of 4 billion base pairs, an average of 1 mutation will occur about every four cell generations.
95. Mutations can only occur in organisms that have sex as part of their life trajectory.

NSLO1a, NSLO2a, NSLO3a, NSLO4a

L. Which of the following societal concerns can be affected by knowledge of biology?

96. Global climate change.
97. GMO regulation.
98. Public health regulations.
99. Hunting and fishing seasons.
100. Industrial regulations.

NSLO4a, NSLO6a