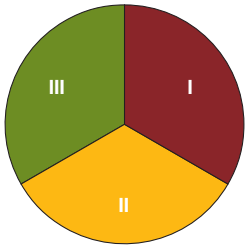
Biology: Content Essays (0233)

Test at a Glance

Test Name	**Biology: Content Essays**
Test Code	**0233**
Time	**1 hour**
Number of Questions	**3 questions, one each in cellular and molecular biology, genetics and evolution, and organismal biology and ecology**
Format	**Multipart questions requiring extended written responses in English**



Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
I. Molecular and Cellular Biology	1	33.3%
II. Classical Genetics and Evolution	1	33.3%
III. Organismal Biology and Ecology	1	33.3%

About This Test

The Biology: Content Essays test is designed to measure the subject-area knowledge and competencies necessary for a beginning teacher of biology in a secondary school. A beginning teacher needs to have an in-depth knowledge of scientific concepts and the ability to integrate such knowledge with the biological sciences. Questions are derived from topics typically covered in an introductory college-level biology course.

The one-hour test consists of three equally weighted essay questions that assess examinees' ability to use and analyze important biological concepts. One question is in the area of molecular and cellular biology, the second in the area of genetics and evolution, and the third in the area of organismal biology, including diversity of life and ecology. (For a description of these content areas, see the Biology: Content Knowledge, Part 1, Test 0231.)

One question will assess an examinee's skills in data analysis, experimental design, and investigation; the second will assess understanding of concepts, models, and systems; and the third will assess the ability to deal with issues concerning science, technology, and society.

- Data analysis, experimental design, and investigation questions evaluate examinees' ability to design experiments that test simple hypotheses, analyze and interpret data, suggest demonstrations that illustrate concepts, and propose investigations within a specific content area.
- Concepts, models, and systems questions evaluate examinees' ability to use scientific knowledge to formulate major concepts, to understand model use and limitations and to communicate the process by which scientists create and use models, and to understand the interacting components of a functional biological system.
- Science, technology, and society questions evaluate examinees' ability to discuss the impact of science and technology on society and to demonstrate an understanding of the scientific concepts and principles involved.

Sample Test Questions

This section presents sample questions and constructed-response samples along with the standards used in scoring the essays. 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 questions will be asked and must decide, on the spot, how to respond. Readers take these circumstances into account when scoring the responses.

Readers will assign scores based on the following scoring guide.

SCORING GUIDE

5

- Demonstrates a superior understanding of the science concepts required by the question
  - gives clear, accurate, and well-reasoned explanations
  - uses accurate scientific terminology throughout
  - when required, provides accurate and well-chosen supporting evidence (e.g., data, examples)
  - any diagrams, tables, and graphs presented are complete, clear, accurate, and well organized

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- Demonstrates a strong understanding of the science concepts required by the question
  - gives clear, accurate, and logical explanations
  - uses accurate terminology
  - when required, provides accurate and relevant supporting evidence (e.g., data, examples)
  - any diagrams, tables, and graphs presented are generally complete, accurate, and organized

3

- Demonstrates an adequate understanding of the science concepts required by most parts of the question
  - gives generally clear, accurate, and logical explanations
  - uses some accurate scientific terminology
  - when required, provides accurate and relevant supporting evidence (e.g., data, examples)
  - any diagrams, tables, and graphs presented are sufficiently complete and accurate

2

- Demonstrates a limited understanding of the science concepts required by the question, as evidenced by one or more of the following characteristics:
  - may give insufficiently accurate and/or poorly developed explanations
  - may lack accurate scientific terminology
  - when required, may give little supporting evidence (e.g., data, examples)
  - any diagrams, tables, and graphs presented may be incomplete and/or inaccurate

1

- Demonstrates very little understanding of the science concepts required by the question, as evidenced by one or more of the following characteristics:
  - may give inaccurate, illogical, incoherent, or seriously incomplete explanations
  - may fail to use accurate scientific terminology
  - may give little or no supporting evidence (e.g., data, examples)
  - any diagrams, tables, and graphs presented may be seriously inaccurate, confusing, or incomplete

0

- Completely inaccurate or inappropriate, blank, or off topic

Sample Question 1

Darwin proposed that the mechanism of evolution was natural selection acting on heritable variation within a population. Darwin, however, could not account for these sources of variation. How do the principles of genetics account for this variation?

Sample Response That Received a Score of 4:

Darwin knew nothing of genes or chromosomes when he wrote "The Origin of Species", yet through his observations of morphology, he was able to describe accurately what is now supported by extensive research of genetics: the theory of organic evolution by natural selection. Darwin observed the phenotypic variation within populations. The variations result from the various proportions of different alleles (alternate versions of genes) which make up the gene pool. These alleles may have entered the gene pool through mutation or through immigration. The gene pool for a particular population provides all possible phenotypes for that population. The phenotypes expressed are acted upon by natural, or environmental factors. Some traits (or phenotypes) are ideally suited for the particular environment. Whether the trait is for keen eyesight, a prehensile tail, or anaerobic respiration, those organisms possessing the traits that best suit the organism are said to be successful in terms of survival and reproduction. Those organisms that do not possess traits that are beneficial in a particular environment or possess traits that are adverse in that environment are not successful in one or both measurements of survival or reproduction. Those that do reproduce pass on 1/2 of their genome to each offspring, if they reproduce sexually, or a full set of their genome, if they reproduce asexually. Random segregation of chromosomes and independent assortment of unlinked genes increases genetic variability. In sexually reproducing organisms, crossing over during meiosis creates even more new combinations of traits on which selection may act. The genome is known to code for the proteins that together produce the traits of the offspring. We know now that genetic information is the source of inherited traits. The classic experiments done to prove that DNA is the genetic material came from exposing non-virulent pneumococcus to dead virulent pneumococcus. The non-virulent strain acquired the DNA of the virulent strain and became virulent. Since those experiments the structure of DNA has been theorized, and sequences of DNA have been mapped or located within chromosomes. Mendel's work with pea plants expressed the possibility of dominance and recessiveness in traits of organisms, a fact which is proven by the allelic nature of genes.

Sample Response That Received a Score of 3:

Darwin observed finches and other animals and proposed that they must be descended from a common ancestor. Because the finches or other animals lived in different environments and ate different foods and looked different from one another, he suggested that adaptations in some animals, such as beak shape in the finches, had been selected by some aspect of the environment, such as food supply, because these adaptations helped the animals survive and reproduce.

Genetic variation allows for variation in the animals such as different beak shapes. This variation comes from the mixing up of genes on chromosomes in the eggs and sperm produced by the parents. When the eggs and sperm are being made, crossing over of chromosomes occurs so that new combinations of genes are passed on to the offspring. Some of these new combinations help the offspring survive and some do not, depending on the environment. If a combination does help, then this is an adaptation and the animal lives. If a combination does not help, the animal will probably die before reproducing.

Sample Response That Received a Score of 1:

Darwin postulated evolution through adaptation and mutation, or in a sense "survival of the fittest". We know through genetics and studies of chromosomes that "traits" that benefit the organism normally survive and that those that don't cease to exist. Statistically, recessive traits fell at the short end of the stick and frequency of their occurrence is dependent on parent cells.

As the environment changes, traits that are more conducive to survival are passed on while those that fail to provide a benefit, die. The structure of chromosomes, and activity of cell structures is inherent throughout both Kingdoms.

Sample Question 2

Discuss the impacts on society and on the environment of each of the following.

(A) Combustion of fossil fuels

(B) Use of chemical pesticides

Sample Response That Received a Score of 5:

The combustion of fossil fuels has been a blessing and a curse.

A blessing because it has allowed us to develop technologies such as high speed transportation, allowing better distribution of food and goods, cities where people can live and work together, and time for cultural and leisure activities.

A curse because it has led to severe air and water pollution. The products of smoke stacks have killed forests in North America, Europe, and Asia. When coal and oil are burnt in large quantities gases such as sulfur oxides and nitrogen oxides are emitted. These are carried by wind currents across the globe. As they travel they are converted chemically to acids such as sulfuric acid and nitric acid. These fall to the earth as acid rain and cause a lot of damage. For example the acid rain can damage marble, it can leach nutrients from soil, and it can kill fish and other organisms in ponds and lakes. Air pollution resulting from the burning of fossil fuels can also affect people, especially if they have respiratory problems. This adds a burden to the medical services. The burning of fossil fuels also contributes to increased carbon dioxide levels in the atmosphere. This together with pollutant gases serves to prevent heat radiation from exiting the atmosphere. As the level of carbon dioxide continues to rise, the climate is changing. It is thought that the polar ice caps will continue to melt raising the sea levels such that low lying places such as Florida will be under water.

Of course, even if we do nothing, we will not burn fossil fuels forever because we will run out. They are a non-renewable resource. But we could conceivably choke, poison, or heat ourselves to death before all of the oil, gas, and coal is used up.

The use of chemical pesticides demonstrates that, when we first started to use them, we did not know enough about how the worlds of plants, insects, animals, and humans interact. DDT was hailed as a miracle chemical. It was sprayed everywhere. Unfortunately it is insoluble in water, soluble in fat, and breaks down very slowly in the environment. It also concentrates in body tissue.

DDT killed mosquitos at first, but of course some always remained that were more unaffected by it. These resistant mosquitos bred uncontrolled by their natural enemies who were also killed by the DDT. Eventually DDT no longer worked. By this time the animals had been accumulating quite a lot of DDT in their tissues. This caused the shells of bird eggs to become so thin that the shells broke when they were incubated. We almost lost the U.S. symbol, the bald eagle, due to DDT use. DDT is also very persistent in the environment. Traces have been found at the North and South Poles. In most areas of the world we have stopped using it. But some countries are still using it because it is cheap monetarily. Unfortunately, it is environmentally expensive.

We are now just beginning to use a form of integrated pest management. We do not always spray chemicals at the first sight of infestation. It has been found that a crop can withstand a pretty heavy infestation and still produce a good harvest. Some people are using predator insects which eat the “bad” ones. There are carnivorous snails that eat garden snails not plants. Something else we are experimenting with is the release of sterile insects to mate with the “wild” insects. This causes a decline of population.

Most of the pesticides can also harm people and other animals either directly or indirectly through the food chain. Pesticides such as DDT end up in terrestrial and aquatic organisms at low trophic levels of food webs. Particularly because many of these pesticides are fat soluble, they become increasingly concentrated in consumers at higher trophic levels. Many farm workers, pesticide factory workers, and children become ill due to exposure to toxic pesticides, especially the organophosphates. This is more common in the least developed nations because regulations are not as strict and people are not educated about the dangers. This brings into question the benefits of using these pesticides. Certainly without them food would be a lot more expensive because it would be less plentiful.

We have been using these things since the end of WWII. Before that, we managed pretty well. Perhaps we should ease off on the use of chemical pesticides until and unless we really know what we are doing.

Sample Response That Received a Score of 3:

Examples of fossil fuels are petroleum, natural gas, and coal. They are of great importance because they can be burned and release lots of energy. The Industrial Revolution took place because fossil fuels, especially coal, provided the energy for factories. Today, homes and all sorts of vehicles depend on fossil fuels. We get light and heat and can cook because we use gas or coal. We can travel because we use gas.

The bad thing about fossil fuels is that burning them pollutes the air. This leads to problems like acid rain and global warming .

Chemical pesticides are very important because they allow us to grow crops without pests eating them before they get to us in the grocery store. These pesticides can be sprayed over many acres to protect whole fields and farms from things like worms and moths. This means that farmers can grow large crops and sell them to the public at reasonable prices.

The bad thing about chemical pesticides is that they can make people and animals around them sick. Just as the pesticides kill pests, they can also accidentally harm others. In addition to making animals sick, the pesticides can be stored in the animals and then be taken up by people or other animals that eat the sick ones. We need to be careful to use just the right amount of pesticide, just enough to kill pests.

Sample Response That Received a Score of 1:

Combustion of fossil fuels is an environmental issue, we can't actually see into the future to find out or know how the mining of fossil fuels will affect the land and air. We do see the effect of fossil fuel use on our air. The use of chemical pesticides can be useful. There are also problems, since any killing can affect the food chain. A delicate food chain balance is interrupted.

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