

**Massachusetts  
Tests for Educator Licensure<sup>®</sup> (MTEL<sup>®</sup>)**



**Biology (13)**

**PRACTICE TEST**



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## **TABLE OF CONTENTS**

Introduction .....	1
Purpose of the Practice Test .....	1
Taking the Practice Test .....	1
Incorporating the Practice Test in Your Study Plan .....	1
Biology Practice Test .....	2
General Test Directions .....	3
Multiple-Choice Answer Sheet .....	4
Multiple-Choice Questions .....	5
Directions for the Open-Response Item Assignments .....	28
Open-Response Item Assignments and Response Sheets .....	29
Practice Test Results .....	35
Practice Test Results Overview .....	36
Multiple-Choice Question Answer Key Worksheet .....	37
Multiple-Choice Question Practice Test Evaluation Chart .....	40
Open-Response Item Evaluation Information .....	44
Open-Response Item Scoring Rubric, Sample Responses, and Analyses .....	45
Practice Test Score Calculation .....	58

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## **INTRODUCTION**

This document is a printable version of the Massachusetts Tests for Educator Licensure® (MTEL®) Biology (13) Online Practice Test. This practice test is a sample test consisting of 100 multiple-choice questions and 2 open-response item assignments.

To assist you in recording and evaluating your responses on the practice test, a Multiple-Choice Answer Sheet, an Answer Key Worksheet, and an Evaluation Chart by test objective are included for the multiple-choice questions. A blank Response Sheet, Evaluation Information, and Sample Responses and Analyses, as well as a Scoring Rubric, are included for the open-response items. Lastly, there is a Practice Test Score Calculation worksheet.

## **PURPOSE OF THE PRACTICE TEST**

The practice test is designed to provide an additional resource to help you effectively prepare for the MTEL Biology (13) test. The primary purpose of the practice test is to help you become familiar with the structure and content of the test. It is also intended to help you identify areas in which to focus your studies. Education faculty and administrators of teacher preparation programs may also find this practice test useful as they help students prepare for the official test.

## **TAKING THE PRACTICE TEST**

In order to maximize the benefits of the practice test, it is recommended that you take this test under conditions similar to the conditions under which the official MTEL tests are administered. Try to take the practice test in a quiet atmosphere with few interruptions and limit yourself to the four-hour time period allotted for the official test administration. You will find your results to be more useful if you refer to the answer key only after you have completed the practice test.

## **INCORPORATING THE PRACTICE TEST IN YOUR STUDY PLAN**

Although the primary means of preparing for the MTEL is your college education, adequate preparation prior to taking or retaking the MTEL test is strongly recommended. How much preparation and study you need depends on how comfortable and knowledgeable you are with the content of the test.

The first step in preparing to take the MTEL is to identify what information the test will address by reviewing the objectives for your field. A complete, up-to-date list of the Test Objectives is included in the Test Information Booklet for each test field. The test objectives are the core of the testing program and a helpful study tool. Before taking or retaking the official test, focus your study time on those objectives for which you wish to strengthen your knowledge.

This practice test may be used as one indicator of potential strengths and weaknesses in your knowledge of the content on the official test. However, because of potential differences in format and difficulty between the practice test and an official MTEL Biology (13) test, it is not possible to predict precisely how you might score on an official MTEL Biology (13) test. Keep in mind that the subareas for which the test weighting is greatest will receive emphasis on this test. Refer to the Test Information Booklet for additional information about how to prepare for the test.

**BIOLOGY  
PRACTICE TEST**

## **GENERAL TEST DIRECTIONS**

This practice test consists of two sections: (1) a multiple-choice question section and (2) an open-response item assignment section. Each multiple-choice question on the practice test has four answer choices. Read each question carefully and choose the ONE best answer. Record each answer on the answer sheet provided.

- Sample Question:
1. What is the capital of Massachusetts?
    - A. Worcester
    - B. New Bedford
    - C. Boston
    - D. Springfield

The correct answer to this question is C. You would indicate that on the answer sheet.

The open-response section of this practice test requires written responses. Directions for the open-response item assignments appear immediately before those assignments.

You may work on the multiple-choice questions and open-response item assignments in any order that you choose. You may wish to monitor how long it takes you to complete the practice test. When taking the actual MTEL Biology (13) test, you will have one four-hour test session in which to complete the test.

**MULTIPLE-CHOICE ANSWER SHEET**

<b>Question Number</b>	<b>Your Response</b>
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## MULTIPLE-CHOICE QUESTIONS

1. Formulating a testable hypothesis is particularly important when:
  - A. determining cause and effect relationships between observable phenomena.
  - B. interpreting a model that can be used to describe the workings of a natural system.
  - C. explaining the interactions of all natural phenomena in terms of a few basic laws.
  - D. describing as many characteristics as possible of living and nonliving things.
2. A student is planning a science fair project that involves comparing the effects of two different fertilizers on grass growth. Two 10 m<sup>2</sup> plots are laid out on a large, unshaded lawn, and fertilizer A is applied to one plot and fertilizer B to the other. The plots are watered equally at regular intervals. After three weeks the grass is mowed and the clippings weighed. Which of the following changes in the design would most improve the experiment?
  - A. applying a broad spectrum insecticide
  - B. increasing the dimensions of the plots
  - C. adding a plot to which no fertilizer is applied
  - D. using plant numbers instead of biomass

3. Which of the following best describes the importance of having a control group in an experiment?
- A. insuring reproducibility of the results
  - B. facilitating the peer review process
  - C. reducing potential bias by the observer
  - D. isolating the effect of a single variable
4. A researcher is studying the effects of acid precipitation on the mortality of frogs in a local pond during the summer. To best assess the pH of the pond for the purposes of this study, the researcher should sample the pond:
- A. before and after a heavy rain, in the days following a rain, and during times of drought.
  - B. each week on the same day and at the same time of day.
  - C. when water flow into the pond and the water level of the pond are near their summer averages.
  - D. randomly with respect to days of the week and the time of day.
5. A student is doing an experiment to determine how change in acidity affects enzyme activity. The time it takes for a disk soaked with catalase at different acidities to rise to the top of a vial containing 1% hydrogen peroxide will be measured. If the student presents the findings in a line graph, which of the following conditions will be represented on the  $x$ -axis of the graph?
- A. pH values
  - B. catalase concentrations
  - C. disk rise times
  - D. percent hydrogen peroxide

6. Use the table below to answer the question that follows.

Trial number	1	2	3	4	5	6	7
Temperature (°C)	25	26	29	29	20	24	22

The data table shows the average sample temperature during each of seven experimental trials. If  $x$  represents the mode,  $y$  represents the median, and  $z$  represents the mean, which of the following expressions is true?

- A.  $z = y < x$
- B.  $x < z < y$
- C.  $z = x < y$
- D.  $x < y < z$
7. A study is being conducted to determine whether there is a causal link between a recently built chemical factory and the health of people in the surrounding area. Which of the following types of information would most strongly suggest that there is a causal relationship?
- A. visible air pollution in nearby neighborhoods
- B. historical links between chemical manufacturing and human health issues
- C. opinions of people living near the chemical plant
- D. increases in the number of patients being treated for asthma in nearby medical facilities

## Biology (13) Practice Test

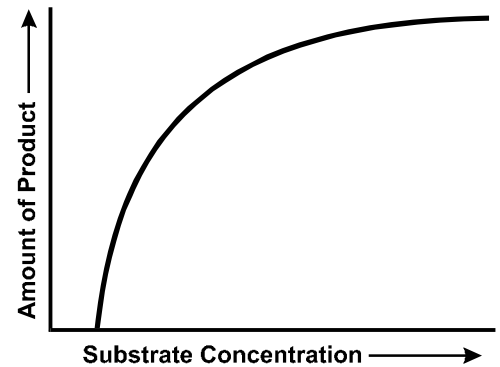
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8. While cleaning the cages of the class's pet guinea pigs, a student picks up one of the animals in an ungloved hand and receives a deep bite. The teacher should be aware that, as a result of this incident, the student could be at risk for contracting:
- A. plague.
  - B. distemper.
  - C. encephalitis.
  - D. tetanus.
9. An excess of a chemical measured out for use in a laboratory experiment should be:
- A. returned to the original stock.
  - B. reported on a Material Safety Data Sheet form.
  - C. disposed of according to state guidelines.
  - D. labeled and set aside for use in the future.
10. A teacher is planning to lead a class of students on a field trip to a local park in Massachusetts where they will collect representatives of different types of insects. Before leaving for the park, it would be most important that the teacher ensure that the first-aid box contains an emergency kit for preventing:
- A. allergic reactions to bee stings.
  - B. contact with bacteria that cause Lyme disease from a tick bite.
  - C. spread of poison from a snake bite.
  - D. infection with West Nile virus from a mosquito bite.
11. Which of the following factors was primarily responsible for the initial increase in  $O_2$  in the earth's atmosphere?
- A. the escape of gases from volcanoes
  - B. the emergence of multicellular organisms
  - C. the photosynthesis of cyanobacteria
  - D. the condensation of water into oceans

12. Some people are concerned that transgenic agricultural crops might transfer genes to other species. Which of the following is the basis for this concern?
- Plant genes have promoter sequences that are similar to those of microbes.
  - Transgenic plants can spread altered DNA through their pollen.
  - Some microbes are known to exchange DNA through conjugation.
  - Transgenic DNA is designed to be incorporated into new genomes.
13. A story in a newspaper reports that post-surgical patients who received a type of alternative therapy involving light touching of the body report less severe pain than those who did not receive the therapy. The story concludes that this therapy should be adopted in all hospitals. Which information would be most useful to a reader in assessing the validity of this conclusion?
- the percentage of patients in all hospitals who report that they have experienced severe pain after undergoing surgery
  - the estimated cost to hospitals of providing the alternative therapy to all of their postsurgical patients
  - the percentage of patients reporting reduced pain after receiving other forms of attention such as traditional massage or talking with staff
  - the level of pain reported by post-surgical patients before and after they received the alternative therapy
14. The ability of plants to transport water and dissolved nutrients against the force of gravity is directly attributable to the:
- cohesion of water molecules.
  - breaking of hydrogen bonds in liquid water.
  - temperature-induced changes in water density.
  - high specific heat of liquid water.
15. A solution with a pH of 3 is how many times more acidic than a solution with a pH of 6?
- 2x
  - 10x
  - 1000x
  - 2000x
16. The immense diversity of biological molecules results most directly from the:
- reactivity of oxygen.
  - mass of phosphorus.
  - availability of nitrogen.
  - structure of carbon.

17. Biologically important properties of water such as its cohesion, high specific heat, anomalous phase densities, and role as a solvent can be attributed primarily to the:
- A. tendency of water molecules to form double bonds.
  - B. hydrogen bonds that form between water molecules.
  - C. relatively low molecular weight of water compared to other liquids.
  - D. ability of water to dissociate into hydrogen and hydroxide ions.
18. Saturated fats are best distinguished from unsaturated fats by the fact that saturated fats:
- A. are more likely to be solid at room temperature.
  - B. contain more cholesterol.
  - C. are more common in plants than in animals.
  - D. contain more double bonds.

19. Use the graph below to answer the question that follows.



The graph shows the relationship between the amount of product of a reaction and the substrate concentration for a reaction that is catalyzed by an enzyme. Which of the following is the best explanation for the flattening of the curve at higher concentrations of the substrate?

- A. There is a competitive inhibitor present.
  - B. The enzyme is being denatured.
  - C. The substrate has been used up.
  - D. The active site of the enzyme is saturated.
20. The end of the general belief in the spontaneous generation of life led to the widespread acceptance of which of the following scientific concepts?
- A. cell theory
  - B. endosymbiosis
  - C. natural selection
  - D. uniformitarianism

21. Which of the following enables plant cells to achieve enough structural rigidity to support the overall plant?
- A. the stacking of thylakoids within the chloroplasts
  - B. the osmotic pressure within the central vacuole
  - C. the facilitated diffusion of proteins across the plasma membrane
  - D. the matrix of polysaccharides in the cytoskeleton
22. Rough endoplasmic reticulum is particularly well developed in cells that:
- A. secrete proteins or glycoproteins.
  - B. detoxify drugs or poisons.
  - C. support chemiosmosis.
  - D. hydrolyze macromolecules.
23. Which of the following structures are typically found in both plant and animal cells?
- A. cell walls
  - B. Golgi apparatus
  - C. lysosomes
  - D. central vacuoles
24. Which of the following characteristics allows a virus to propagate itself without killing its host cell?
- A. nature of the protein coat on the virus
  - B. absence of restriction enzymes in the cell
  - C. existence of a provirus stage in its life cycle
  - D. RNA as the viral genetic material
25. Which of the following processes is most likely to cause an increase in the level of lactic acid within a cell?
- A. hydrolysis
  - B. respiration
  - C. glycolysis
  - D. fermentation
26. The Calvin cycle is the process by which:
- A. carbon dioxide is fixed and converted into carbohydrates.
  - B. hydrogen ions are generated and used to make NADPH.
  - C. electrons become excited and are used to produce ATP.
  - D. oxygen is removed from water molecules and released as a gas.

## Biology (13) Practice Test

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27. The mechanism by which ATP provides energy for the metabolic processes of a cell involves the:
- A. generation of heat by hydrolysis of a phosphate group.
  - B. transfer of a phosphate group to other molecules.
  - C. lowering of the activation energy required for phosphorylation.
  - D. absorption of light by pigments during phosphorylation.
28. Which of the following situations best demonstrates phagocytosis?
- A. A bacterium is surrounded by a plasma membrane, engulfed, and enclosed by a vacuole.
  - B. An antigen binds to a specific receptor on the surface of a plasma membrane, which invaginates around the antigen.
  - C. A food particle is surrounded by a plasma membrane, engulfed, and diffuses through the lipid bilayer.
  - D. An antibody within the cell is enclosed in a vesicle that fuses with the plasma membrane and releases the antibody from the cell.
29. Unlike mitosis, binary fission:
- A. occurs in prokaryotic cells.
  - B. requires formation of a spindle.
  - C. increases genetic variability.
  - D. results in identical daughter cells.
30. One application of gene therapy is the delivery of *p53* genes to cells. These genes cause cells that malfunction to undergo programmed death. This method would be most effective at:
- A. preventing cancer from being inherited.
  - B. treating polygenic disorders related to cancer.
  - C. inhibiting the development of cancerous tumors.
  - D. improving the response of healthy cells to chemotherapy.
31. A germinating fern spore will develop into:
- A. a protonema.
  - B. a gametophyte.
  - C. an archegonium.
  - D. a sporophyte.

32. The double fertilization that is unique to the reproduction of angiosperms has which of the following consequences?
- Polyploidy and hybridization are more common in plants than in animals.
  - Two pollen grains are necessary to fertilize each ovum.
  - Zygotes form during both the gametophyte and sporophyte generations.
  - Food storage tissue in seeds is triploid.
33. An important difference in how aquatic autotrophs and land plants carry out photosynthesis is that only land plants:
- receive carbon dioxide through specialized structures.
  - have chlorophyll *a*, which allows them to absorb red and blue light.
  - produce NADPH during the light reactions.
  - use a chemiosmotic mechanism for producing ATP.
34. Closure of stomata immediately affects a plant's:
- root pressure.
  - transport of nutrients.
  - rate of water loss.
  - frost resistance.
35. Bean leaves growing under constant environmental conditions in a laboratory raise and lower their leaves on a 26-hour cycle. This is an example of a:
- phototropism.
  - circadian rhythm.
  - day-neutral behavior.
  - photoperiodic response.
36. Which of the following describes the triple response of seedlings that allows them to push up through the soil to the surface?
- phototropism; ethylene emission; programmed cell deaths
  - slowing of stem elongation; thickening of stem; horizontal growth of stem
  - changes in turgor pressure; phytochromes; blue-light receptors
  - variation in auxin concentrations; production of growth inhibitors; abscission layers
37. Lichens obtain their carbon and nitrogen from the:
- photosynthesis and nitrogen fixation of green algae or cyanobacteria.
  - absorption of decomposing organic material.
  - accumulation of wind-borne particulate matter.
  - assimilation of solutes dissolved in precipitation.

38. After two prokaryotes undergo conjugation:
- A. one cell resides inside the other as an endosymbiont.
  - B. each cell divides and produces two daughter cells.
  - C. the genetic material of one cell is altered by the process.
  - D. both cells remain attached to each other and begin to form a colony.

39. Roundworms are among the most primitive organisms that have a

- A. nerve net.
- B. digestive tract.
- C. respiratory organ.
- D. circulatory system.

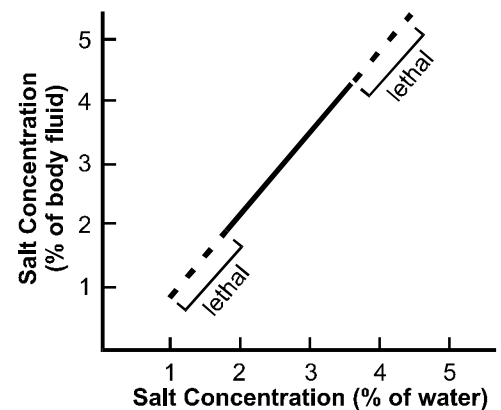
40. Hydrostatic skeletons are characteristic of which of the following groups of animals?

- A. myriapods
- B. sponges
- C. insects
- D. annelids

41. Among the protists, the distinguishing feature of the protozoa is their:

- A. movement through fluids using cilia or flagella.
- B. consumption of other microbes for nutrients and energy.
- C. ability to aggregate in response to chemical signals.
- D. reproduction by binary fission rather than by spores.

42. Use the graph below to answer the question that follows.



The graph above shows the change in salt concentration in the cells of a spider crab as the salt concentration of the surrounding water changes. The data suggest that with respect to salt concentration the spider crab is:

- A. regulating its internal environment.
- B. using a positive feedback mechanism to maintain homeostasis.
- C. conforming to the external environment.
- D. using a negative feedback mechanism to maintain homeostasis.

43. In birds which of the following characteristics is most likely to be correlated with a monogamous mating relationship?
- A. male and female sexual dimorphism
  - B. cryptic coloration
  - C. young that require constant feeding
  - D. seasonal migration
44. Which of the following characteristics of vertebrates is a necessary consequence of being bilaterally symmetrical?
- A. a true body cavity
  - B. an endoderm layer
  - C. an interior skeleton
  - D. a right and a left side
45. One reason that birds are better able than mammals to function at high altitudes is that birds:
- A. rely on negative pressure breathing rather than on positive pressure breathing.
  - B. pass air over the gas exchange surfaces in one direction only.
  - C. maintain a lower partial pressure of oxygen in the lungs than do mammals.
  - D. have oxygen-carrying proteins in addition to hemoglobin.
46. Panting by mammals is part of a feedback response that cools the body by:
- A. hyperventilating the lungs.
  - B. dilating capillaries in the mouth and throat.
  - C. triggering a countercurrent heat exchange.
  - D. increasing evaporative heat loss.
47. A veterinarian finds that a cat has a lesion on its hypothalamus. This injury would most directly affect the cat's ability to:
- A. coordinate muscle movements.
  - B. regulate its body temperature.
  - C. perceive visual stimuli.
  - D. control its breathing.
48. Which of the following is a function performed by the liver?
- A. regulation of blood flow to the stomach during digestion
  - B. generation of new red and white blood cells
  - C. removal of wastes and toxins from the blood
  - D. control of peristalsis in the digestive tract

49. Which of the following best describes the function of bile salts in the process of digestion?
- A. bonding to the surface of amino acids to allow them to be actively pumped against the concentration gradient by epithelial cells
  - B. lowering stomach pH to produce the acid environment necessary for the proper functioning of enzymes and the destruction of pathogens
  - C. coating fat droplets and preventing them from coalescing to expose more surface of the droplets to the action of hydrolytic enzymes
  - D. cleaving bonds of amino acids to break long polypeptide chains into smaller segments that can be more easily absorbed
50. Which of the following is the primary cause of most peptic ulcers in humans?
- A. bacterial infection
  - B. frequent ingestion of spicy foods
  - C. viral eruption
  - D. regular use of antacids
51. Which of the following best describes an important role of the lymphatic system in circulation?
- A. returning fluid and blood proteins lost by capillaries back to the veins
  - B. transporting carbon dioxide released from cells to the bloodstream
  - C. maintaining electrolyte balance of body fluids within tolerance limits
  - D. removing damaged red and white blood cells from circulation
52. Which of the following best describes the role of clonal selection in the development of acquired immunity to a pathogen?
- A. Leukocytes that are stimulated as a result of increased body temperature during an infection differentiate from their precursor stem cells more rapidly.
  - B. Lymphocytes that possess receptors that can bind to the pathogen's antigens rapidly divide to produce many cells capable of recognizing and attacking the pathogen.
  - C. Natural killer cells that produce antibodies capable of attacking the pathogen are stimulated to produce more antibodies than cells that do not produce such antibodies.
  - D. Phagocytes that ingest many pathogens over a short period of time grow and divide more rapidly than those that have not ingested many pathogens.

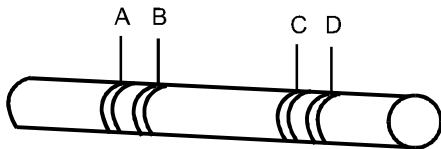
53. Evidence suggests that fever can help fight infection and return the body to homeostasis by:
- A. reducing the permeability of plasma membranes to pathogens.
  - B. increasing the concentration of oxygen in the blood.
  - C. lowering blood pressure and heart rate.
  - D. enhancing production and mobility of leukocytes.
54. Which of the following best describes an aneurysm and its effect on circulation?
- A. An aneurysm is a blood clot that may stick in an artery and restrict blood flow.
  - B. An aneurysm is a deposit of plaque on the wall of an artery that may impede or block blood flow.
  - C. An aneurysm is an abnormal connection between an artery and a vein that can lead to decreased oxygen delivery to tissues.
  - D. An aneurysm is a weak spot in the wall of an artery that may rupture and cause a major hemorrhage into surrounding tissues.
55. Which of the following best describes the function of the cilia that are attached to the epithelial lining of the bronchi and bronchioles of the lungs?
- A. producing mucous and other secretions that trap pathogens
  - B. insulating delicate lung tissue from exposure to cold inhaled air
  - C. moving particulate contaminants upward to the pharynx
  - D. trapping inhaled oxygen molecules for transfer to the blood
56. Which of the following best describes the mechanism by which hemoglobin loads and unloads oxygen?
- A. Production of  $\text{CO}_2$  during cellular respiration lowers blood pH, which decreases the affinity of hemoglobin for oxygen and facilitates the unloading of oxygen to cells.
  - B. Oxygen molecules binding to one subunit of a hemoglobin molecule change its shape, and the other three subunits also change shape and accept oxygen more readily.
  - C. Blood arriving at the lungs has a lower  $\text{PO}_2$  pressure than the air inside the lungs, which favors the diffusion of oxygen into the blood from the lungs.
  - D. Carbon dioxide in the blood as a result of increased cellular respiration causes the heart's pacemaker to speed up and increase the transport of oxygen to cells.

57. The sensation of thirst is produced by the brain primarily in response to signals from the body indicating:
- A. decreased heart rate and blood pressure.
  - B. increased internal temperatures.
  - C. decreased urinary output by the kidneys.
  - D. increased osmolarity of the blood.
58. Which of the following best describes a difference between the peripheral nervous system and the central nervous system?
- A. Axons within the peripheral nervous system are longer since they must stretch from cell bodies in the ganglia located along the spine to their destinations in the tissues.
  - B. Nerve cells that are located within the peripheral nervous system have many more dendrites than those that are located within the central nervous system.
  - C. Synapses within the peripheral nervous system are electrical rather than chemical and so do not require the use of neurotransmitters to transmit information.
  - D. Impulses in the peripheral nervous system carry information from the body to the brain, while those in the central nervous system carry it from the brain to the body.
59. In invertebrates, the speed at which an action potential travels along an axon is directly proportional to the axon's diameter. However, vertebrate axons have narrow diameters, but can still conduct action potentials at very high speeds. This is true because vertebrate axons:
- A. contain higher concentrations of water that increase the conductivity.
  - B. possess a lipid-rich myelin sheath that functions as electrical insulation.
  - C. operate at higher body temperatures that reduce electrical resistance.
  - D. generate action potentials that use sodium rather than calcium to generate electrical impulses.
60. Which of the following best describes the role played by the hormone oxytocin in human reproduction?
- A. inducing and regulating uterine contractions during the second and third stage of labor
  - B. stimulating the growth of follicles in the ovary and maturation of the oocytes
  - C. inducing and regulating the disintegration of the uterine lining during menstruation
  - D. stimulating the development of the endometrium in preparation for pregnancy

61. The "fight or flight" response to a stress is initiated when nerve impulses stimulate the:
- A. thyroid to produce the hormones triiodothyronine and thyroxine.
  - B. posterior pituitary to release the tropic hormone adrenocorticotrophic hormone.
  - C. adrenal medulla to secrete the catecholamines, epinephrine and norepinephrine.
  - D. parathyroid glands to release the glucocorticoid hormone cortisol.
62. Which of the following is a major difference between cartilage and other types of connective tissues?
- A. The extracellular matrix in cartilage lacks collagen.
  - B. Cartilage does not contain blood vessels.
  - C. The primary mineral in cartilage is phosphorus rather than calcium.
  - D. Cartilage cells do not possess nuclei.
63. In the human skeleton, which of the following is an example of a pivot joint?
- A. shoulder
  - B. knee
  - C. elbow
  - D. finger
64. Which of the following best describes how muscle fibers contract?
- A. Actin filaments shorten during the early phase of contraction, and myosin filaments shorten during the later phase of contraction.
  - B. Actin and myosin filaments slide past each other without changing their length.
  - C. Actin and myosin filaments wind tightly around each other during contraction, which shortens their lengths.
  - D. Actin filaments shorten during contraction, while myosin fibers stretch.
65. The stratum corneum tissue of human skin consists mainly of dead cells that are continuously sloughed off and replaced by new cells migrating from underlying layers. This structure of the stratum corneum is most related to which of the following functions of skin?
- A. maintaining elasticity and tone in underlying muscle and connective tissue
  - B. eliminating toxins from the body that are produced as a byproduct of metabolism
  - C. facilitating the evaporation of water to help dissipate heat when the ambient temperature is high
  - D. protecting against injury and serving as a barrier against the entry of pathogens

66. Which of the following is the best explanation for the reason that genes located in mitochondrial and plastid DNA do not exhibit a Mendelian pattern of inheritance?
- A. Sex-linkage is frequent in extranuclear genes.
  - B. X chromosomes in female cells condense into Barr bodies.
  - C. Cytoplasm in a zygote comes from the ovum.
  - D. Genomic imprinting favors maternal inheritance.

67. Use the diagram below to answer the question that follows.



The diagram above shows a chromosome map of four genes relative to each other. Which pair of genes would have the highest recombination frequency?

- A. B and A
- B. A and C
- C. B and C
- D. A and D

68. Polyploidy in an organism is most likely to result from a:
- A. frameshift mutation that deletes a termination codon.
  - B. low level of helicase activity during DNA replication.
  - C. reciprocal exchange of material between nonsister chromatids.
  - D. chromosomal nondisjunction during meiosis.
69. During which phase of meiosis is crossing over most likely to occur?
- A. prophase I
  - B. prophase II
  - C. metaphase I
  - D. metaphase II

70. In mammals, black coat color (*B*) is dominant to brown (*b*). However, a gene on a different chromosome determines whether or not color will be deposited in the coat at all. The dominant allele *C* represents color deposition while the recessive allele *c* represents lack of pigment. If two mice heterozygous for both genes are crossed, what fraction of their offspring will be brown?
- A.  $\frac{1}{16}$
- B.  $\frac{3}{16}$
- C.  $\frac{1}{2}$
- D.  $\frac{9}{16}$
71. Upon reaching a ribosome, a tRNA molecule will:
- A. match an anticodon to the complementary mRNA codon.
- B. attach an amino acid to the growing polypeptide chain.
- C. eliminate introns from the mRNA sequence.
- D. terminate the growing polypeptide chain.
72. Which of the following best describes an operator in prokaryotic gene expression?
- A. It is a specific nucleotide sequence that indicates where DNA replication begins.
- B. It removes introns and facilitates the splicing of exons in genes.
- C. It is a transposable genetic element that activates an operon.
- D. It controls access of RNA polymerase to the genes in a transcription unit.
73. One consequence of the redundancy of the genetic code is that:
- A. somatic mutations do not affect the germ line.
- B. nucleotide base deletions may lead to frameshift mutations.
- C. some point mutations have no effect on phenotypic expression.
- D. missense mutations may result in translocations.
74. Which of the following techniques is used to increase the quantity of DNA in a sample to be analyzed?
- A. DNA sequencing
- B. polymerase chain reaction
- C. restriction fragment analysis
- D. DNA hybridization

75. Researchers trying to date speciation events in the past for which fossils are not available sometimes rely on evidence that assumes the:
- A. occurrence of convergent evolution.
  - B. validity of the Hardy-Weinberg equilibrium.
  - C. existence of a molecular clock.
  - D. applicability of the biological species concept.
76. Which of the following pairs is a result of convergent evolution?
- A. a turtle's egg and a frog's egg
  - B. a bird's wing and a bat's wing
  - C. a housefly's leg and a bee's leg
  - D. a human hand and a monkey hand
77. The original source of variation in a genome is:
- A. independent assortment.
  - B. recombination.
  - C. crossing over.
  - D. mutation.
78. The existence of which of the following situations in a natural population would violate the assumptions of a Hardy-Weinberg equilibrium condition?
- A. variable environment conditions
  - B. sexual selection
  - C. high level of phenotypic diversity
  - D. large population size
79. A plant species that is widely distributed on a continent is separated into an eastern and a western population during an ice age. By the time the glaciers retreat, the two populations are morphologically distinct from each other. This is an example of the effect of:
- A. character displacement.
  - B. punctuated equilibrium.
  - C. adaptive radiation.
  - D. geographical isolation.
80. Shifting from the five-kingdom taxonomic scheme to the three-domain scheme by biologists included the:
- A. splitting of the prokaryote kingdom into two prokaryote domains.
  - B. merging of the prokaryote kingdom with the protista into a domain.
  - C. separating of the autotroph kingdom into two different domains.
  - D. grouping of unicellular organisms in different kingdoms into one domain.

81. The conclusion that fungi are more closely related to animals than to green plants is best supported by evidence based on analysis of:

- A. modes of nutrition.
- B. fossil records.
- C. molecular systematics.
- D. phenetic relationships.

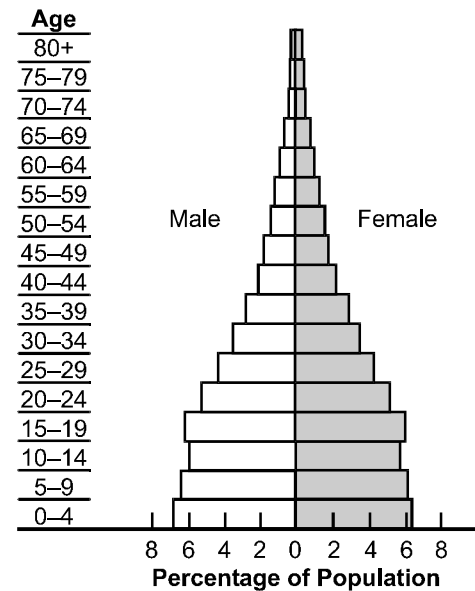
82. If it is to have taxonomic value, the number of spots on a beetle's wing covers must be:

- A. adaptive.
- B. unique to the species.
- C. used in a dichotomous key.
- D. heritable.

83. Which of the following pairs of animals are most closely related phylogenetically?

- A. segmented worms and flatworms
- B. bumblebees and lobsters
- C. sponges and jellies
- D. clams and sea stars

84. Use the diagram below to answer the question that follows.



Based on the age structure table above, the human population that is represented will probably:

- A. continue to grow rapidly.
- B. increase slowly and steadily at a constant rate.
- C. grow for another generation and then stabilize.
- D. remain at its current size.

## Biology (13) Practice Test

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85. Which of the following is an example of a mutualistic relationship between two organisms?
- A. hawks hunting mice during the day and owls hunting mice at night
  - B. ants obtaining food from aphids and protecting them from predators
  - C. ticks feeding on a moose's blood and dispersing at the same time
  - D. bees feeding on thistle nectar and siskins feeding on thistle seeds
86. Thermoclines are related to which of the following characteristics of ecosystems?
- A. the ecotones that exist between grasslands and forests
  - B. the inverse correlation of temperature and elevation
  - C. the zonation of organisms in intertidal habitats
  - D. the vertical stratification of freshwater lakes
87. Which of the following conditions is a particular problem for organisms living in estuaries?
- A. availability of light
  - B. leaching of nutrients
  - C. erosion of substrate
  - D. variation in salinity
88. Which of the following pairs of environmental factors together represents the primary determinant of the distribution of terrestrial biomes worldwide?
- A. mean temperature and precipitation
  - B. elevation and mean precipitation
  - C. mean temperature and soil type
  - D. elevation and soil type

89. When existing species in a habitat alter environmental conditions in such a way that they inhibit their own reproduction in relation to other species, which of the following events is likely to occur?
- A. density independent selection
  - B. habitat fragmentation
  - C. boom and bust population cycles
  - D. secondary succession
90. There is less biomass at higher trophic levels of an ecosystem because at the higher trophic levels:
- A. biodiversity is lower.
  - B. less energy is available.
  - C. decomposers are dominant.
  - D. toxic compounds accumulate.
91. Food webs usually have a maximum of three to five trophic levels. The best explanation for this is the:
- A. limited quantity of energy available to the primary producers.
  - B. elusiveness of high trophic level prey with respect to predators.
  - C. inefficiency of the flow of energy between trophic levels.
  - D. accumulation of potential toxins in organisms at the top of food chains.
92. The phosphorus cycle differs from the carbon and nitrogen cycles in that phosphorus is:
- A. in the same chemical form throughout its cycle.
  - B. not produced as a result of human activities.
  - C. not in a gas phase during any part of its cycle.
  - D. rarely a limiting factor in ecosystems.

93. Which of the following statements about the carbon cycle is accurate?
- A. Decomposers and other heterotrophs absorb carbon dioxide from the atmosphere during respiration.
  - B. Calcium carbonate from dead organisms is a primary reservoir of carbon stored in ocean sediments.
  - C. The main source of carbon dioxide returning to the atmosphere is the respiration of terrestrial consumers from the higher trophic levels.
  - D. More carbon dioxide is absorbed by an acre of living trees in a year than is released by an acre of trees burning during a fire.
94. The reason why introducing phosphate-free detergents was so successful at cleaning up lakes and rivers is that in freshwater ecosystems phosphorus:
- A. presents osmoregulatory difficulties for zooplankton.
  - B. lowers the pH as a result of increased carbon dioxide levels.
  - C. accumulates in the brown fatty tissues of fish.
  - D. is the limiting nutrient for algal growth.
95. The productivity of fisheries over areas of regular oceanic upwellings is evidence that which of the following conditions is often limiting in open ocean ecosystems?
- A. nutrient availability
  - B. light intensity
  - C. salinity level
  - D. water temperature
96. The primary benefit of contour plowing on a farm is that it:
- A. increases organic matter and helps maintain soil structure.
  - B. reduces the need for irrigation and cultivation.
  - C. increases the angle and availability of incident light.
  - D. reduces soil erosion due to water runoff.

97. Aquatic ecosystems tend to be dead zones near points at which nuclear power plants discharge water because of:
- A. high levels of acidity.
  - B. elevated background radiation.
  - C. decreased light penetration.
  - D. low dissolved oxygen content.
98. The presence of increased levels of nitrogen oxides in the atmosphere is an environmental concern because this can result in:
- A. a decrease in soil fertility as minerals are leached away.
  - B. a decrease in the populations of nitrogen-fixing bacteria.
  - C. an increase in the rate of ozone depletion in the atmosphere.
  - D. an increase in the eutrophication of aquatic ecosystems.
99. The draining of wetlands for development leads directly to increases in which of the following environmental problems?
- A. accumulation of pollutants
  - B. flooding in adjacent habitats
  - C. pressure on nearby landfills
  - D. establishment of exotic species
100. Which of the following is the best way to reduce the environmental consequences associated with clear-cutting forests in mountainous areas?
- A. applying nitrogen and potash fertilizers after logging the site
  - B. closing the logged area to recreational uses until trees are reestablished
  - C. leaving some trees standing on the site when it is logged
  - D. cultivating the soil immediately after logging and planting tree seedlings

## **DIRECTIONS FOR THE OPEN-RESPONSE ITEM ASSIGNMENTS**

This section of the test consists of two open-response item assignments that appear on the following pages. You will be asked to prepare a written response of approximately 150–300 words (1–2 pages) for each assignment. You should use your time to plan, write, review, and edit your response for each assignment.

For each assignment, read the topic and directions carefully before you begin to work. Think about how you will organize your response. You may use any blank space in this test booklet to make notes, write an outline, or otherwise prepare your response.

As a whole, your response to each assignment must demonstrate an understanding of the knowledge of the field. In your response to each assignment, you are expected to demonstrate the depth of your understanding of the subject area by applying your knowledge rather than by merely reciting factual information.

Your response to each assignment will be evaluated based on the following criteria.

- **PURPOSE:** the extent to which the response achieves the purpose of the assignment
- **SUBJECT KNOWLEDGE:** appropriateness and accuracy in the application of subject knowledge
- **SUPPORT:** quality and relevance of supporting evidence
- **RATIONALE:** soundness of argument and degree of understanding of the subject area

The open-response item assignments are intended to assess subject knowledge. Your responses must be communicated clearly enough to permit valid judgment of the evaluation criteria by scorers. Your responses should be written for an audience of educators in this field. The final version of each response should conform to the conventions of edited American English. Your responses should be your original work, written in your own words, and not copied or paraphrased from some other work.

Be sure to write about the assigned topics. Please write legibly. You may not use any reference materials during the test. Remember to review your work and make any changes you think will improve your responses.

Write or print your response in the space provided following the assignment.

**OPEN-RESPONSE ITEM ASSIGNMENT #1**

**Complete the exercise that follows.**

A student is designing an independent study project that will explore the possibility that a contractile vacuole commonly observed in individuals of a species of *Paramecium* is involved in osmotic regulation. Using your knowledge of scientific inquiry, describe a suitable experiment or investigation for the student's project in which you:

- generate a hypothesis that addresses the topic presented in the project description;
- describe an experiment or investigation and explain how it would test the hypothesis; and
- describe the methods used to collect and analyze the data generated.





**OPEN-RESPONSE ITEM ASSIGNMENT #2**

**Complete the exercise that follows, including diagrams or drawings where appropriate.**

Using your knowledge of the structures and functions of the human respiratory system, prepare a response in which you:

- describe the structures of the respiratory system and how they function to ventilate the lungs; and
- analyze the process by which the exchange of respiratory gases occurs, and factors that affect it.





## **PRACTICE TEST RESULTS**

## **PRACTICE TEST RESULTS OVERVIEW**

The practice test provides valuable information regarding your preparedness for the MTEL Biology (13) test. In this section, you will find information and tools to help you determine your preparedness on the various sections of the test.

### **Multiple-Choice Questions**

A Multiple-Choice Question Answer Key Worksheet is provided to assist you in evaluating your multiple-choice responses. The worksheet contains five columns. The first column indicates the multiple-choice question number, the second column indicates the objective to which the test question was written, and the third column indicates the correct response. The remaining columns are for your use in calculating the number of multiple-choice questions you answered correctly or incorrectly.

An Evaluation Chart for the multiple-choice questions is also provided to help you assess which content covered by the test objectives may require additional study.

### **Open-Response Items**

Evaluation Information, Sample Responses and Analyses, as well as a Scoring Rubric are provided for these items. You may wish to refer to this information when evaluating your practice test responses.

### **Total Test**

Practice Test Score Calculation information is provided to help you estimate your score on the practice test. Although you cannot use this practice test to precisely predict how you might score on an official MTEL Biology (13) test, you may be able to determine your degree of readiness to take an MTEL test at an operational administration. No passing score has been determined for the practice test.

**MULTIPLE-CHOICE QUESTION  
ANSWER KEY WORKSHEET**

Question Number	Objective Number	Correct Response	Your Response	
			Correct?	Incorrect?
1	0001	A		
2	0001	C		
3	0001	D		
4	0002	A		
5	0002	A		
6	0002	A		
7	0002	D		
8	0003	D		
9	0003	C		
10	0003	A		
11	0004	C		
12	0004	D		
13	0004	C		
14	0005	A		
15	0005	C		
16	0005	D		
17	0005	B		
18	0005	A		
19	0005	D		
20	0006	A		
21	0006	B		
22	0006	A		
23	0006	B		
24	0006	C		
25	0007	D		
26	0007	A		
27	0007	B		
28	0007	A		
29	0007	A		
30	0007	C		
31	0008	B		
32	0008	D		
33	0008	A		
34	0008	C		

**MULTIPLE-CHOICE QUESTION  
ANSWER KEY WORKSHEET (continued)**

Question Number	Objective Number	Correct Response	Your Response	
			Correct?	Incorrect?
35	0008	B		
36	0008	B		
37	0009	A		
38	0009	C		
39	0009	B		
40	0009	D		
41	0009	B		
42	0009	C		
43	0010	C		
44	0010	D		
45	0010	B		
46	0010	D		
47	0010	B		
48	0011	C		
49	0011	C		
50	0011	A		
51	0012	A		
52	0012	B		
53	0012	D		
54	0012	D		
55	0013	C		
56	0013	A		
57	0013	D		
58	0014	A		
59	0014	B		
60	0014	A		
61	0014	C		
62	0015	B		
63	0015	C		
64	0015	B		
65	0015	D		
66	0016	C		
67	0016	D		
68	0016	D		

**MULTIPLE-CHOICE QUESTION  
ANSWER KEY WORKSHEET (continued)**

Question Number	Objective Number	Correct Response	Your Response	
			Correct?	Incorrect?
69	0016	A		
70	0016	B		
71	0017	A		
72	0017	D		
73	0017	C		
74	0017	B		
75	0018	C		
76	0018	B		
77	0018	D		
78	0018	B		
79	0018	D		
80	0019	A		
81	0019	C		
82	0019	D		
83	0019	B		
84	0020	A		
85	0020	B		
86	0020	D		
87	0020	D		
88	0020	A		
89	0020	D		
90	0021	B		
91	0021	C		
92	0021	C		
93	0021	B		
94	0021	D		
95	0021	A		
96	0022	D		
97	0022	D		
98	0022	A		
99	0022	B		
100	0022	C		

**Count the number of multiple-choice questions you answered correctly:**

\_\_\_\_\_ of 100 multiple-choice questions

**MULTIPLE-CHOICE QUESTION  
PRACTICE TEST EVALUATION CHART**

In the evaluation chart that follows, the multiple-choice questions are arranged in numerical order and by test objective. Check your responses against the correct responses provided to determine how many questions within each objective you answered correctly.

**Subarea I: Nature of Science**

**Objective 0001: Understand the dynamic nature of scientific inquiry and scientific processes.**

1A\_\_\_ 2C\_\_\_ 3D\_\_\_ \_\_\_\_\_/3

**Objective 0002: Understand the processes of gathering, organizing, analyzing,  
and reporting scientific data.**

4A\_\_\_ 5A\_\_\_ 6A\_\_\_ 7D\_\_\_ \_\_\_\_\_/4

**Objective 0003: Understand scientific instruments, materials, and safety practices.**

8D\_\_\_ 9C\_\_\_ 10A\_\_\_ \_\_\_\_\_/3

**Objective 0004: Understand the historical and contemporary relationships among  
science, technology, and society.**

11C\_\_\_ 12D\_\_\_ 13C\_\_\_ \_\_\_\_\_/3

**Subarea I (Objectives 0001–0004) Total \_\_\_\_\_/13**

**MULTIPLE-CHOICE QUESTION  
PRACTICE TEST EVALUATION CHART (continued)**

**Subarea II: Chemistry of Life and Cell Biology**

**Objective 0005: Understand the chemical components of living systems and basic principles of biochemistry.**

14A \_\_\_ 15C \_\_\_ 16D \_\_\_ 17B \_\_\_ 18A \_\_\_ 19D \_\_\_      \_\_\_/6

**Objective 0006: Understand cell structure and function.**

20A \_\_\_ 21B \_\_\_ 22A \_\_\_ 23B \_\_\_ 24C \_\_\_      \_\_\_/5

**Objective 0007: Understand the physiological processes of cells.**

25D \_\_\_ 26A \_\_\_ 27B \_\_\_ 28A \_\_\_ 29A \_\_\_ 30C \_\_\_      \_\_\_/6

**Subarea II (Objectives 0005–0007) Total \_\_\_/17**

**Subarea III: Characteristics of Organisms**

**Objective 0008: Understand the structures, structural organization, and life processes of plants.**

31B \_\_\_ 32D \_\_\_ 33A \_\_\_ 34C \_\_\_ 35B \_\_\_ 36B \_\_\_      \_\_\_/6

**Objective 0009: Understand the structures, structural organization, and life processes of archaea, bacteria, protists, fungi, and invertebrates.**

37A \_\_\_ 38C \_\_\_ 39B \_\_\_ 40D \_\_\_ 41B \_\_\_ 42C \_\_\_      \_\_\_/6

**Objective 0010: Understand the structures, structural organization, and life processes of vertebrates.**

43C \_\_\_ 44D \_\_\_ 45B \_\_\_ 46D \_\_\_ 47B \_\_\_      \_\_\_/5

**Subarea III (Objectives 0008–0010) Total \_\_\_/17**

**MULTIPLE-CHOICE QUESTION  
PRACTICE TEST EVALUATION CHART (continued)**

**Subarea IV: Human Anatomy and Physiology**

**Objective 0011: Understand the structures and functions of the human digestive system and the principles of nutrition.**

48C\_\_\_ 49C\_\_\_ 50A\_\_\_ \_\_\_\_\_/3

**Objective 0012: Understand the structures and functions of the human circulatory and immune systems.**

51A\_\_\_ 52B\_\_\_ 53D\_\_\_ 54D\_\_\_ \_\_\_\_\_/4

**Objective 0013: Understand the structures and functions of the human respiratory and excretory systems.**

55C\_\_\_ 56A\_\_\_ 57D\_\_\_ \_\_\_\_\_/3

**Objective 0014: Understand the structures and functions of the human nervous, endocrine, and reproductive systems.**

58A\_\_\_ 59B\_\_\_ 60A\_\_\_ 61C\_\_\_ \_\_\_\_\_/4

**Objective 0015: Understand the structures and functions of the human skeletal, muscular, and integumentary systems.**

62B\_\_\_ 63C\_\_\_ 64B\_\_\_ 65D\_\_\_ \_\_\_\_\_/4

**Subarea IV (Objectives 0011–0015) Total \_\_\_\_\_/18**

**MULTIPLE-CHOICE QUESTION  
PRACTICE TEST EVALUATION CHART (continued)**

**Subarea V: Genetics, Evolution, and Biodiversity**

<b>Objective 0016: Understand the principles of heredity.</b>					
66C	67D	68D	69A	70B	____/5

<b>Objective 0017: Understand the molecular basis of genetics.</b>					
71A	72D	73C	74B		____/4

<b>Objective 0018: Understand the theories and mechanisms of evolution.</b>					
75C	76B	77D	78B	79D	____/5

<b>Objective 0019: Understand biodiversity and classification.</b>					
80A	81C	82D	83B		____/4

**Subarea V (Objectives 0016–0019) Total \_\_\_\_/18**

**Subarea VI: Populations, Ecosystems, and the Environment**

<b>Objective 0020: Understand populations, communities, ecosystems, and biomes.</b>						
84A	85B	86D	87D	88A	89D	____/6

<b>Objective 0021: Understand the cycling of materials and the transfer of energy through an ecosystem.</b>						
90B	91C	92C	93B	94D	95A	____/6

<b>Objective 0022: Understand the effects of human activities on the environment.</b>					
96D	97D	98A	99B	100C	____/5

**Subarea VI (Objectives 0020–0022) Total \_\_\_\_/17**

## OPEN-RESPONSE ITEM EVALUATION INFORMATION

### How Open-Response Items Are Scored

Open-response items are scored through a process called focused holistic scoring. Scorers judge the overall effectiveness of the response rather than individual aspects considered in isolation. Scorer judgments are based on the quality of the response, not on length or neatness. Responses must be long enough to cover the topic adequately and scorers must be able to read what is written.

### How to Evaluate Your Practice Responses

On the following pages, you will find two "strong" and two "weak" sample responses. PLEASE DO NOT REVIEW THE SAMPLE RESPONSES UNTIL AFTER YOU HAVE WRITTEN YOUR OWN RESPONSE. When you do review the two "strong" and "weak" sample responses and analyses included here, please note the following points:

- ✓ For the purposes of the practice test, responses are identified as "strong" or "weak" rather than given a score point of 1–4.
- ✓ The responses identified as "strong" may contain flaws; however, these responses do demonstrate the performance characteristics of a "strong response."
- ✓ The two "strong" responses demonstrate the examinees' appropriate understanding and application of the subject matter knowledge. However, these responses do not necessarily reflect the full range of "correct answers" that would demonstrate an understanding of the subject matter.
- ✓ The "Analysis" accompanying each "strong" and "weak" response discusses the main attributes of the responses, but does not identify all flaws or strengths that may be present.

Compare your practice responses to the Sample Responses to determine whether your responses are more similar to the strong or weak responses. Also review the Analyses on those pages and the Scoring Rubric to help you better understand the characteristics of strong and weak responses. This evaluation will help you identify specific problems or weaknesses in your practice responses. Further information on scoring can be found in the Test Information Booklet and Faculty Guide at [www.mtel.nesinc.com](http://www.mtel.nesinc.com) and at [www.doe.mass.edu/mtel](http://www.doe.mass.edu/mtel); select "FAQ," then "After the Test."

**OPEN-RESPONSE ITEM  
SCORING RUBRIC, SAMPLE RESPONSES, AND ANALYSES**

Massachusetts Tests for Educator Licensure®  
**SCORING RUBRIC FOR SUBJECT TESTS**

**Performance Characteristics:**

Purpose	The extent to which the response achieves the purpose of the assignment.
Subject Matter Knowledge	Accuracy and appropriateness in the application of subject matter knowledge.
Support	Quality and relevance of supporting details.
Rationale	Soundness of argument and degree of understanding of the subject matter.

**Scoring Scale:**

Score Point	Score Point Description
<b>4</b>	<p><b>The "4" response reflects a thorough knowledge and understanding of the subject matter.</b></p> <ul style="list-style-type: none"> <li>• The purpose of the assignment is fully achieved.</li> <li>• There is a substantial, accurate, and appropriate application of subject matter knowledge.</li> <li>• The supporting evidence is sound; there are high-quality, relevant examples.</li> <li>• The response reflects an ably reasoned, comprehensive understanding of the topic.</li> </ul>
<b>3</b>	<p><b>The "3" response reflects an adequate knowledge and understanding of the subject matter.</b></p> <ul style="list-style-type: none"> <li>• The purpose of the assignment is largely achieved.</li> <li>• There is a generally accurate and appropriate application of subject matter knowledge.</li> <li>• The supporting evidence is adequate; there are some acceptable, relevant examples.</li> <li>• The response reflects an adequately reasoned understanding of the topic.</li> </ul>
<b>2</b>	<p><b>The "2" response reflects a limited knowledge and understanding of the subject matter.</b></p> <ul style="list-style-type: none"> <li>• The purpose of the assignment is partially achieved.</li> <li>• There is a limited, possibly inaccurate or inappropriate, application of subject matter knowledge.</li> <li>• The supporting evidence is limited; there are few relevant examples.</li> <li>• The response reflects a limited, poorly reasoned understanding of the topic.</li> </ul>
<b>1</b>	<p><b>The "1" response reflects a weak knowledge and understanding of the subject matter.</b></p> <ul style="list-style-type: none"> <li>• The purpose of the assignment is not achieved.</li> <li>• There is little or no appropriate or accurate application of subject matter knowledge.</li> <li>• The supporting evidence, if present, is weak; there are few or no relevant examples.</li> <li>• The response reflects little or no reasoning about or understanding of the topic.</li> </ul>
<b>U</b>	<b>The response is unrelated to the assigned topic, illegible, primarily in a language other than English, not of sufficient length to score, or merely a repetition of the assignment.</b>
<b>B</b>	<b>There is no response to the assignment.</b>

## FIRST SAMPLE WEAK RESPONSE FOR OPEN-RESPONSE ITEM ASSIGNMENT #1

My hypothesis would be that parameciums are NOT involved in osmotic regulation.

The experiment would involve the paramecium and the control of the regulation of the salinity within the cell. The paramecium would be subjected to several different salinity levels at varying concentrations to see how it reacts. By observing and recording the interactions of the paramecium I would be able to prove/disprove by the data that was collected and see if the hypothesis was proven or disproven.

## ANALYSIS FOR FIRST WEAK RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #1

*This is an example of a weak response because it is characterized by the following:*

**Purpose:** The purpose of the assignment was not in focus in this response. The candidate does not generate a testable hypothesis. The candidate is vague about the design of the experiment, revealing limited knowledge of the topic.

**Subject Matter Knowledge:** The hypothesis presented does not address the assignment. Rather than testing how the contractile vacuoles function in osmotic regulation, the candidate presents an experiment that tests the paramecium. The only information given about the experiment is that it would involve paramecia at different levels of salinity, but little extra information is provided. This response fails to demonstrate subject matter knowledge of how to conduct a scientific investigation.

**Support:** Support is weak throughout this response. The hypothesis strays from the assignment by testing the paramecium rather than investigating the role of the contractile vacuole in osmotic regulation. Few details are provided about the design of the experiment. *What interactions would be observed? How would the data be recorded and analyzed?* The inaccuracies and missing information weaken the response.

**Rationale:** Beginning with a hypothesis that does not address the assignment, the response fails to fully address the other two parts of the question. By failing to discuss how the data would be analyzed, the response presents an incomplete answer to the assignment where no single part of the question is addressed with complete understanding.

## SECOND SAMPLE WEAK RESPONSE FOR OPEN-RESPONSE ITEM ASSIGNMENT #1

First, the student should come up with a testable hypothesis: If a paramecium is put in a salty environment then its contractile vacuole will be more active.

A student could begin her experiment by taking a paramecia and putting it in a freshwater solution and observe the number of vacuole contractions within a given time.

The experiment could be repeated by adding salt to the freshwater to change its salinity level. Both experiments should be repeated to verify the results.

## ANALYSIS FOR SECOND WEAK RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #1

*This is an example of a weak response because it is characterized by the following:*

**Purpose:** The purpose of the assignment is partially achieved. A testable hypothesis is provided, but the experimental design and collection and analysis of data is only briefly addressed.

**Subject Matter Knowledge:** The response demonstrates limited subject matter knowledge about scientific inquiry. While a testable hypothesis was provided, the experimental design left out critical components such as a control, testing at different levels of salinity, and the analysis of results in order to draw a conclusion.

**Support:** The lack of support—especially in the area of experimental design—weakens the response. Leaving out a "control" would make it difficult to analyze data. Not measuring the amount of salt added to the freshwater would introduce a great deal of variability into the investigation.

**Rationale:** All three paragraphs offer discrete bits of information, but the experimental design and analysis of results indicate incomplete understanding of scientific inquiry.

## FIRST SAMPLE STRONG RESPONSE FOR OPEN-RESPONSE ITEM ASSIGNMENT #1

For this situation the experimental hypothesis is that a contractile vacuole will contract fewer times as salinity of the medium increases. The null hypothesis would be that there is no change in the contraction rate.

To test this a control would be a sample of water from the paramecium's shipping container. Observe several paramecia for three minutes each, count the number of contractions in that time and record. This is now the control.

Repeat this procedure by adding a known amount of salt to the medium, counting the number of contractions of several paramecia over three minutes each. Record the data.

Repeat the procedure several more times, each time increasing the salinity with a known amount of salt.

Once all the data has been collected, you could find the average number of contractions at each level of salinity and plot it on a graph as the dependent variable. The amount of salt is the independent variable. If the average number of contractions decreased as salinity increased, the hypothesis would be proven.

The data can be carefully collected by counting contractions with a handheld counter and stopwatch. Since the medium might heat up due to the light in the microscope, you should wait a few minutes between each step to allow the medium to return to room temperature. A bar graph or line graph could be used.

## ANALYSIS FOR FIRST STRONG RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #1

*This is an example of a strong response because it is characterized by the following:*

**Purpose:** The purpose of the assignment is fully achieved. All parts of the question are addressed in a comprehensive manner. The response contains a hypothesis relative to the topic. An experiment that would test the hypothesis is described and explained. The response presents a clear procedure to guide observations as well as data collection and analysis.

**Subject Matter Knowledge:** The candidate demonstrates accurate subject matter knowledge and a depth of understanding of the scientific method. The procedure is based on a clearly stated hypothesis. A valid experimental design is established which includes a "control" and a "variable." Appropriate materials for carrying out the experiment, such as the *Paramecium* organisms, salt, a stopwatch, and a handheld counter are identified. Repeating trials, using several samples, and taking the average demonstrates a clear understanding and application of the scientific method. Finally, the response cites graphing as a way to analyze and interpret data.

**Support:** The response is strengthened by the quality of the supporting details that are provided. Dependent and independent variables are included. All steps of the experimental method are accurately sequenced, adding precise supportive detail to the response.

**Rationale:** The response presents a logical, accurate, and well-sequenced approach to designing an investigation or experiment. The steps involved in carrying out the experiment are clearly stated. The candidate fully addresses the topic in a straightforward, comprehensive manner that is easy to follow.

**SECOND SAMPLE STRONG RESPONSE FOR OPEN-RESPONSE  
ITEM ASSIGNMENT #1**

My hypothesis would be that the contractile vacuole of a Paramecium functions in the regulation of osmotic regulation.

I would obtain some Paramecia from a supplier and observe the behavior of the contractile vacuoles in their natural medium. How large did the contractile vacuoles become before contracting? How many contractions were made per unit of time? I would observe eight Paramecia for two minutes each. If this seemed too small a time, I'd increase the time to provide sufficient data. I would record the data by taking the average. Using this as my control, I will keep all the conditions the same as I begin to test my hypothesis.

I will add 5 grains of salt to the water medium and observe the behavior of the contractile vacuoles of eight Paramecia for my established time frame. I will record my data using an average, and shut the microscope light off so the medium does not overheat or evaporate.

I would repeat the experiment several times, adding 5 more grains of salt each time.

Since I would be observing two things--size of vacuole before contraction and number of contractions per time period--I would make two charts. The number of contractions per time period could be done on a line or bar graph easily. Although precisely measuring the diameter of the contractile vacuole would be difficult to accomplish, any swelling or shrinking could be noted as a +/- change in size.

After analyzing the data, any progressive change in the number of contractions or size of vacuole would prove my hypothesis.

Care would have to be taken by using a timer and maintaining the same conditions throughout.

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## ANALYSIS FOR SECOND STRONG RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #1

*This is an example of a strong response because it is characterized by the following:*

**Purpose:** All parts of the assignment are addressed. The purpose of the assignment is fully achieved. The response contains a hypothesis relative to the topic: ". . . the contractile vacuole of a Paramecium functions in the regulation of osmotic regulation." A description of the experiment that would test the hypothesis is included. Observations of what to look for, the contraction rate and size of the contractile vacuoles, are clearly specified in the steps of the experiment. Finally, the response suggests a way to collect, organize, and analyze data.

**Subject Matter Knowledge:** The response demonstrates accurate subject matter knowledge. A strong understanding of the scientific method is presented. The response contains a generalized hypothesis. However, the steps by which the hypothesis may be tested are clearly enumerated—observe the paramecium in its "natural medium" as the control, then observe how the behavior of the contractile vacuoles changes with increasing amounts of salt added to the medium. By comparing the behavior of the paramecium in different environments, the candidate demonstrates an understanding of "variable." Measurement is precisely stated, and ways to organize data—two charts—and ways to analyze data through graphing are included.

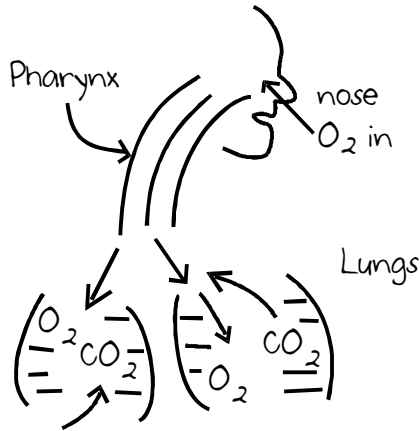
**Support:** The experimental design is valid. The design of the experiment is detailed. The response tells what specific changes to look for, how the data could be recorded, and how the data could be used to show any correlation between contractile vacuole activity and osmotic regulation. These specific details further support and demonstrate the candidate's grasp of relevant concepts and subject matter knowledge related to the topic.

**Rationale:** The response shows a solid understanding of the scientific method. The steps of the experiment are clearly stated. An accurate and logically sequenced approach to conducting a scientific investigation is presented.

**FIRST SAMPLE WEAK RESPONSE FOR OPEN-RESPONSE  
ITEM ASSIGNMENT #2**

As a person inhales, oxygen enters through the nasal cavity and moves down through the pharynx and enters into the lungs where it goes and extends all the way to the aveloes and airsacs within the lungs.

This will exchange the  $O_2$  with the  $CO_2$  and then it is carried out with the contraction of the lungs. Red blood cells are the main carriers of oxygen into the cells.



**ANALYSIS FOR FIRST WEAK RESPONSE TO OPEN-RESPONSE  
ITEM ASSIGNMENT #2**

*This is an example of a weak response because it is characterized by the following:*

**Purpose:** The purpose of the assignment is partially achieved. The response names some structures of the respiratory system and describes the route of air into the lungs. The response does not address how the structures function. The analysis of gas exchange is only briefly mentioned. Since some, but not all, aspects of the two-part question are addressed, the response partially fulfills the purpose of the assignment.

**Subject Matter Knowledge:** The response reflects limited subject matter knowledge about respiratory ventilation. Important structures of the respiratory system such as the trachea, bronchi, and diaphragm are not mentioned. In the diagram, the candidate mislabels the trachea as the pharynx. In addition, a more detailed description of the role of other structures, such as air sacs, is missing. The candidate implies that alveoli ("aveloes") and air sacs are different anatomical structures, which is incorrect. The second part of the question is addressed broadly, through a general statement, but lacks specifics about how and where gases are exchanged.

**Support:** The response cites some structures of the respiratory system, including the nasal cavity and lungs, but leaves out other critically important parts of the system, such as trachea, bronchi, and diaphragm. "Airsacs" are mentioned, but a description of their function is missing. The only reference to gas exchange is "This will exchange the  $O_2$  with the  $CO_2$  and then it is carried out with the contraction of the lungs." *What is the process by which gases are exchanged?* Neither the explanation nor the diagram offer support as to what is happening at the cellular level. The response lacks supportive details that would amplify and provide clarification of general statements made about the respiratory process.

**Rationale:** The response names some structures of the respiratory system, but lacks descriptions of the structure's functions. In addition, the analysis of the process of gas exchange is incomplete. General statements are made but, without additional detailed explanation and description, the response does not demonstrate complete understanding of the topic.

## SECOND SAMPLE WEAK RESPONSE FOR OPEN-RESPONSE ITEM ASSIGNMENT #2

Respiration deals with gleaning of oxygen from the atmosphere and subsequent integration into the blood. Air is drawn through the mouth down the throat, larynx, esophagus, and, into the lungs which expand and contract muscularly. Their interior lining is composed of scilia-like bronchiole tubes with which to absorb the oxygen and infuse prana throughout the organism.

## ANALYSIS FOR SECOND WEAK RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #2

*This is an example of a weak response because it is characterized by the following:*

**Purpose:** The purpose of the assignment is partially achieved. Some structures of the respiratory system are identified and the ventilation process is broadly described. The second part of the assignment is attempted but the answer lacks accuracy. The analysis of gas exchange is not addressed.

**Subject Matter Knowledge:** The response reflects limited subject matter knowledge of the respiratory process. The first sentence, "Respiration deals with the gleaning of oxygen from the atmosphere and subsequent integration into the blood," is accurate. However, the structures that form the respiratory system—the nasal cavity, trachea, bronchi, alveoli, and diaphragm—are not mentioned and the description of those structures is missing. In addition, nothing is said about how air is drawn into the lungs. Finally, little evidence of understanding the gas exchange process is provided.

**Support:** While the response contains a list of some structures—including the mouth, larynx, and lungs—the details describing the role of each structure within the respiratory system are missing. Some statements are inaccurate (e.g., ". . . the lungs which expand or contract muscularly"; the esophagus connects the mouth to the stomach, not the lungs). Little detailed support is provided to demonstrate understanding of the gas exchange process. The reference to "prana" adds little value and moves the response in the wrong direction.

**Rationale:** Although the response includes some accurate information, the candidate displays only a limited understanding of the respiratory system. Some respiratory structures are listed, but the role of the structures lacks description. The second part of the response strays from the topic and fails to explain gas exchange.

**FIRST SAMPLE STRONG RESPONSE FOR OPEN-RESPONSE  
ITEM ASSIGNMENT #2**

The main function of the respiratory system is to take  $O_2$  from the atmosphere, bring it into the body, pass it through the bloodstream, oxygenate the cells in the body, and exhale  $CO_2$  out of the body.

The basic structures of the respiratory system include the nose, mouth, trachea, epiglottis, lungs, bronchioles, capillaries, and blood cells. All of these structures allow oxygen to get from the air to any part inside of the body. A person begins by inhaling from either the nose or mouth. The gases move toward the trachea, passing the epiglottis. The epiglottis is a flap of tissue which covers the trachea and prevents choking if you are eating or swallowing. Along the way, cilia hairs act as a filter, trapping dust and pollen. The air moves into the lungs. Moving through bronchiole tubes, air moves toward alveolar sacs, tiny grape-shaped pouches which are surrounded by capillary networks. It is here where  $O_2/CO_2$  exchange into and out of the bloodstream happens. The  $O_2$  is then sent all over the body on red blood cells via the circulatory system. The air, by the way, is pulled into the body as a result of differential air pressure when the diaphragm contracts and the chest expands.

Because the blood arriving in the alveoli has lower oxygen partial pressure and higher  $CO_2$  partial pressure than in the lungs, the gases exchange before the re-oxygenated blood moves toward the heart before it is pumped out toward the cells of the body via the systemic arteries.

Some of the oxygen travels to cells in the plasma of blood, but most attaches to hemoglobin, a protein which has a central iron atom which can bind with molecules of  $O_2$ . As the blood travels through the systemic capillaries, oxygen leaves the blood and diffuses into tissue. This process continues as long as you are alive. During exercise, the amount of  $O_2$  delivered increases. Factors such as activity level can affect pH levels and oxygen transport.

## ANALYSIS FOR FIRST STRONG RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #2

*This is an example of a strong response because it is characterized by the following:*

**Purpose:** The candidate fulfills the purpose of the assignment by naming the structures of the respiratory system, by describing how those parts function to ventilate the lungs, and by analyzing the process of gas exchange.

**Subject Matter Knowledge:** The response shows a strong grasp of subject matter knowledge. Specific biological terms are used correctly—diaphragm, systemic arteries, hemoglobin, etc.—with clear, complete, and accurate explanations of how air is inspired and oxygen and CO<sub>2</sub> are transported. The response analyzes and discusses what happens during the gas exchange process, demonstrating subject matter knowledge of this topic.

**Support:** The quality and amount of supportive details add strength and depth to the response. In addition to the major parts of the respiratory system being correctly identified, minor—but important—parts, such as the epiglottis and cilia, are included and accurately explained. In addition, the explanation of gas exchange includes a discussion of why the gases exchange and how they flow through the body. Also included is the consideration of O<sub>2</sub> needs during exercise. Citing specific details such as ". . . hemoglobin, a protein which has a central iron atom which can bind with molecules of O<sub>2</sub>" and including descriptive, accurate explanations related to the topic further demonstrates the candidate's grasp of relevant concepts and subject matter knowledge.

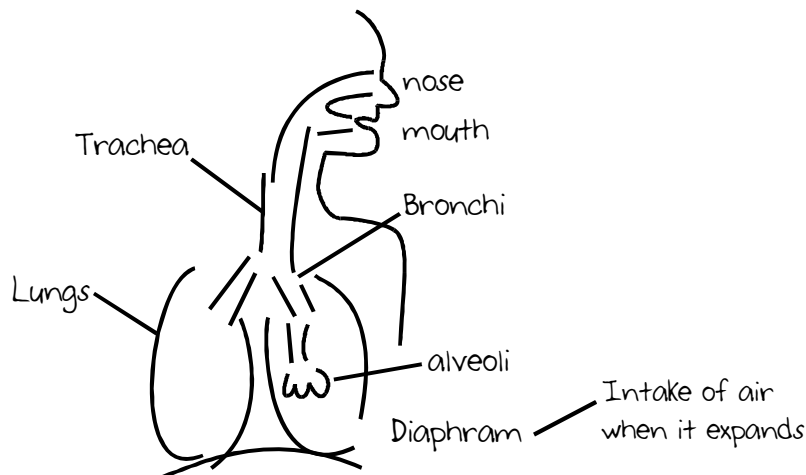
**Rationale:** The response is clearly reasoned throughout. The candidate's thought sequence is accurate and contains clearly sequenced descriptive explanations of the respiratory system and gas exchange.

## SECOND SAMPLE STRONG RESPONSE FOR OPEN-RESPONSE ITEM ASSIGNMENT #2

The respiratory system is comprised of many parts which are used to exchange oxygen from the air with carbon dioxide in your body. The cells that make up your body need the gas exchange to produce energy and remove wastes.

The first thing that happens when you breathe is the contracting of your diaphragm. As your diaphragm contracts your ribs expand, creating negative air pressure inside your lungs. This pulls air from the outside into your mouth and nose. Air travels down your trachea and enters the lungs. Bronchi act like pipes carrying air toward alveoli which hold the oxygen molecules while  $\text{CO}_2$  is released from capillaries. The  $\text{O}_2$  comes in contact with blood cells inside the capillaries which surround the alveoli and bronchi. Blood cells and plasma, after dumping  $\text{CO}_2$ , pick up oxygen. The cells filled with oxygen move toward the heart before they are pumped throughout the body.

My diagram shows the location of the parts of the system:



Once the air is inside the alveoli, the important process of gas exchange begins. In gas exchange,  $\text{CO}_2$  and oxygen exchange places in the alveolar sacs based on partial pressures.  $\text{CO}_2$  is exhaled--released from the body--while oxygen is transported to the cells so it can be used as an input in cellular respiration. When oxygen diffuses from the alveoli into the blood its journey is just beginning. Hemoglobin molecules have a great affinity for oxygen and carry the majority of  $\text{O}_2$  to cells; some  $\text{O}_2$  travels via plasma. The Bohr effect, the result of  $\text{H}^+$  and  $\text{CO}_2$  binding to hemoglobin, can impact how much  $\text{O}_2$  is unloaded during exercise when compared to unloading at rest.

## ANALYSIS FOR SECOND STRONG RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #2

*This is an example of a strong response because it is characterized by the following:*

**Purpose:** The purpose of the assignment is fully achieved. The response addresses both parts of the question. A description of the structures of the respiratory system and their functions is presented and a detailed explanation of the process of gas exchange is discussed.

**Subject Matter Knowledge:** The response contains biological terms that are used accurately to explain the process by which air is inhaled and moved to the lungs. The diagram graphically demonstrates the candidate's understanding of human anatomy by adding additional clarifying preciseness that further reinforces the explanation. Specific explanatory examples of diffusion and CO<sub>2</sub> transport provide additional strength to the response, demonstrating strong subject matter knowledge.

**Support:** The response includes an accurate diagram to support the explanation of how the structures and organs of the respiratory system are organized. Further, the explanation of the flow of air into the body is accurate and is presented in a sequential manner. The specific role of the blood cells in the system is addressed: "Blood cells and plasma, after dumping CO<sub>2</sub>, pick up oxygen. . . ." In addition to the diagram, specific examples of diffusion and CO<sub>2</sub>/O<sub>2</sub> transport are provided. All of this high-quality supportive detail contributes to the candidate's discussion of respiratory ventilation.

**Rationale:** By explaining the respiratory system at both the macro and cellular level in a clear and accurate way, the candidate shows a strong understanding of the topic.

## **PRACTICE TEST SCORE CALCULATION**

The practice test score calculation information will be available in winter 2010, following setting of qualifying scores.