USABO Open Exam 2022

1. Linezolid was the first of the oxazolidinone antibiotics to enter clinical use and targets the 23S rRNA ribosomal subunit of Gram-positive bacteria. *Staphylococcus aureus* has been observed to develop resistance to linezolid by methylation of A2503 in the 23S rRNA. This is an example of antibiotic resistance via:

A. Changes in antibiotic target by mutation.
B. Multidrug efflux pumps.
C. Reduced permeability.
D. Protection by modification.
E. Inactivation by transfer of a chemical group.

2. Which of the following amino acid sequences is MOST likely to be found in a transmembrane domain of a membrane spanning protein?

A. ACLTRLELTFH.
B. APGRHEIPGR.
C. AEDHEDTPGE.
D. AFTAYCLIFFAL.
E. AMMGDEGETM.

3. In 2006, Dr. Shinya Yamanaka demonstrated that mature cells could be made into pluripotent stem cells (iPSCs) by inserting four transcription factors: Sox2, Oct4, Klf4 and c-Myc. These transcription factors enable the production of a variety of proteins, including telomerase. He did this by constructing a retrovirus with the genes for these transcription factors, which was then introduced into human fibroblasts. Which of the following is NOT correct about iPSCs?

A. Genomic integration of these transcription factors can result in mutation of the host cell genome.
B. After the iPSC divides 1000 times, the daughter cells will still be able to divide.
C. Inserting at a locus with high histone deacetylation prevents the host cell from becoming pluripotent.
D. iPSCs are more susceptible to immune rejection than allografts transplants.
E. Expression of the four transcription factors off plasmids instead of through retroviral transduction reduces the risk of cancer.

4. The Hedgehog (Hh) signal transduction pathway that plays an essential role during the development of vertebrate embryos and organogenesis. Hh signaling is involved in STEM cell maintenance. Abnormal regulation of this pathway is linked to tumorigenesis, more specifically the development of tumors resistant to chemotherapeutics. Current research is looking into chemicals that target this pathway to serve as a more effective cancer treatment mechanism. Given what you know about signal transduction pathways, what might be the primary targets for potential

therapeutics within the Hh pathway?

A. Inhibiting proteins in this pathway from interacting with each other.
B. Irreversibly binding genes that are regulated by the Hh pathway.
C. Mimicking the signaling molecule, ensuring the pathway is always "turned on".
D. Increasing the production of the receptor protein.
E. Targeting the ribosome to prevent protein synthesis.

5. You are working in a drug discovery lab that is developing small-molecule inhibitors of the telomerase protein as a potential cancer therapy. Shown below is a model of the key catalytic site of the human telomerase protein. You are responsible for designing a tripeptide molecule that can bind to residues Lys 626, Val 867, and Asp 868. Which of the following tripeptides will bind the strongest to these three amino acids? Assume that the first amino acid in the tripeptide will bind to K626, the second amino acid will bind to V867, and the third will bind to D868.

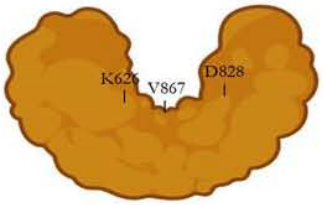


Figure 1. Human telomerase protein indicating key catalytic site. Created using Biorender.com

A. Asp - Ser – His.
B. Glu - Pro – Asn.
C. Asp - Val – Glu.
D. Glu - Ile – Arg.
E. Arg - Ser – Phe.

6. Plants from an unknown ecosystem use Nutrient X as a component of a very important secondary metabolite AL-1. When X is not present, plants produce a significantly less effective alternative AL-2. The production of both metabolites is stopped once they reach a certain concentration. Assuming Nutrient X and AL-2 are both regulators of AL-2's biosynthetic enzymes, which of the following combinations would most likely describe how they work?

I. Strong inducer
II. Weak inducer
III. Strong corepressor
IV. Weak corepressor

A. X is the strong inducer; AL-2 is the weak inducer.
B. X is the weak inducer; AL-2 is the weak corepressor.
C. X is the strong inducer; AL-2 is the weak corepressor.
D. X is the strong corepressor; AL-2 is the weak corepressor.
E. X is the weak corepressor; AL-2 is the strong inducer.

7. Which of the following signaling mechanisms passes a signal from one cell to another fastest?

A. Synaptic neurotransmitter.
B. Gap junction.
C. Protein phosphorylation cascade.
D. Two-component systems.
E. Paracrine.

8. You are screening a new anti-cancer drug "MIT" which targets canonical tyrosine kinase "IVY". MIT that prevents the ligand binding and stops downstream pathways from activating. To visualize the impact of MIT on that natural conformation of IVY, you plan a series of NativePAGE Western blots; an assay which keeps intact the normal structure of proteins. For the first set of blots, you test samples WITHOUT MIT ADDED and use an antibody targeting IVY. As expected with typical tyrosine kinases you see two bands, shown below:



Figure 2. NativePAGE analysis without MIT added. Credit: Common Files

For the second blot, you test samples WITH MIT ADDED. Compared to the initial results, you visualize the blot that was probed with antibodies targeting IVY. You notice that the band closer to the _____ is less intense. These results indicate that MIT disrupts _____

A. Bottom; dimerization.
B. Bottom; protein folding.
C. Top; protein folding.
D. Top; dimerization.
E. No change; protein-protein interactions.

9. A patient comes in with a urinary tract infection and you, their health care provider, need to determine the best antibiotic to use. Since microorganisms can be resistant to some antibiotics you need to perform a test to determine to which antibiotics the microbe will be sensitive or resistant.

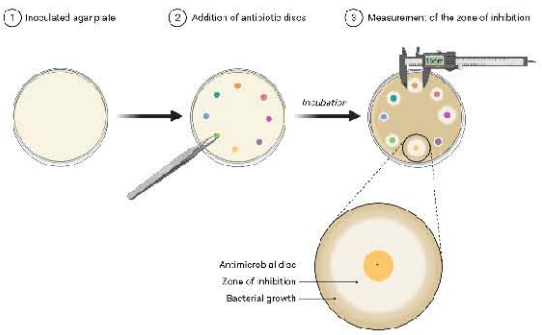


Figure 3. Testing for antibiotic resistance. Credit: Biorender.com

Bacteria isolated	***Escherichia coli D23***		
	Test Data	**Previously Defined Parameters**	
Antibiotic	**Clearance Zone**	**Sensitivity Zone**	**Resistant Zone**
Amoxicillin	14	> 8	< 4
Amoxicillin-clavulanate	18	> 6	< 4
Sulfamethoxazole-trimethoprim	6	> 11	< 8
Ciprofloxacin	13	> 8	< 4
Levofloxacin	2	> 4	< 2
Cephalexin	10	> 12	< 6
Nitrofurantoin	2	> 10	< 6
Piperacillin-Tazobactam	6	> 4	< 2

Using the information gathered, which antibiotic would be best for the patient to receive if they are penicillin (amoxicillin) allergic?

A. Nitrofurantoin.
B. Ciprofloxacin.
C. Cephalexin.
D. Amoxicillin-clavulanate.
E. Sulfamethoxazole-trimethoprim.

10. The D614G mutation in the spike protein of the SARS-CoV-2 virus, which changes an aspartic acid side chain to a glycine side chain, has become predominant in the Covid-19 pandemic. This phenomenon is classified as:

A. Nonsense mutation.
B. Missense mutation.
C. Silent mutation.
D. Truncating mutation.
E. Iatrogenic mutation.

11. For a silvery plant with dorsiventral leaves, the side with the most hairs will be the

A. Adaxial side, side because it receives the most sunlight.
B. Abaxial side, side because it receives the most sunlight.
C. Adaxial side, side because the hairs will help to increase the boundary layer.
D. Abaxial side, side because the hairs will help to increase the boundary layer.
E. Either the abaxial or adaxial side.

12. The amount of water that plants transpire varies geographically and over time. Many factors affect transpiration rates. Which statement below in FALSE?

A. Colder temperatures cause the stomata to close.
B. Decreased moisture causes plants to senesce and transpire less water.
C. Increases in relative humidity surrounding the plant causes the transpiration rate to fall.
D. Increasing temperatures decrease transpiration.
E. Wind movement around the leaf results in a more saturated air close to the leaf.

13. Which statement below is FALSE regarding gymnosperms?

A. The gametophyte is smaller than the sporophyte.
B. Most gymnosperms lack vessel elements in their xylem.
C. Gymnosperms are homosporous.
D. Female gametophytes are dependent on the parent sporophyte for nutrition.
E. Ginkgo biloba is classified as a gymnosperm.

14. nce upon a time, Jack received some mysterious beans from an old man, and decided to grow them to study their flowering properties. When he exposed one plant to 8 hours of light and 16 hours of darkness, the plant flowered. When he exposed another plant to 16 hours of light and 8 hours of darkness, the plant did not flower. Last, when he exposed a third plant to 8 hours of light and 16 hours of darkness interrupted halfway by a flash of far-red light, the plant flowered. Which statement below is TRUE regarding the photoperiodism of this plant?

A. It is a long-day plant.
B. It is a short-day plant.
C. It is a day-neutral plant.
D. It is a submerged aquatic plant.
E. It exhibits a photoperiod inconsistent with those typically found on Earth.

15. Which sequence most accurately explains mass flow in the phloem?

I. Solutes are transported actively into the sieve elements.
II. Sugar is transported in the leaf from cell to cell.
III. Sugar moves down the stem.
IV. Water diffuses into the sieve elements.
V. Sugar is produced in the leaves via photosynthesis.

A. V, IV, II, I, III.
B. V, II, I, IV, III.
C. V, II, IV, I, III.
D. IV, V, I, II, III.
E. II, V, IV, I, III.

16. Location of Photosynthetic Reactions: Which statement below is TRUE about the localization of the photosynthetic reactions within the chloroplast?

A. The Calvin-Benson cycle occurs in the thylakoid interior.
B. Photosystems I and II are built into the inner chloroplast membrane.
C. Protons diffuse through ATP synthases from the outside to the inside of the thylakoids.
D. Carbon fixation occurs in the stroma.
E. ATP is formed in the interior of the thylakoids.

17. Place the following root layers in order from the center of the root to the outside of the root.

I. Cortex
II. Endodermis
III. Epidermis
IV. Pericycle
V. Xylem
A. III, I, II, IV, V.
B. III, I, IV, II, V.
C. I, III, II, IV, V.
D. I, III, IV, II, V.
E. III, IV, II, I, V.

18. Researchers recently discovered a small molecule named Substance RM, which binds to plant phytochrome proteins and reverses the state of these proteins. When P is exposed to Substance RM, it is converted into P_r, and when P_r is exposed to Substance RM, it is converted into P_{fr}. In which of the following scenarios will chrysanthemums, which are short-day plants with a critical night length of 15 hours when exposed to Substance RM flower?

I. Chrysanthemums exposed to sunlight for 12 hours, then exposed to Substance RM, and finally exposed to darkness for 12 hours.
II. Chrysanthemums exposed to sunlight for 12 hours, then exposed to darkness for 12 hours, and finally exposed to substance RM.
III. Chrysanthemums exposed to sunlight for 18 hours, then exposed to darkness for 6 hours, and finally exposed to substance RM.
IV. Chrysanthemums exposed to sunlight for 18 hours, then exposed to Substance RM, and finally exposed to darkness for 6 hours.

A. I, III.
B. II, IV.
C. I, II, III.
D. I, III, IV.
E. II, III, IV.

19. The lateral line system is a necessary system for the survival in most fish. A key part of the lateral line is a substructure called the *cupula*. Though humans do not have lateral lines, they do have a cupula. Where would you expect to find a cupula in a human?

A. Semicircular canal.
B. Dorsal root ganglion.
C. Islet of Langerhans.
D. Central sulcus.
E. Lingual papilla.

20. The normal order of blood flow through a human's heart is,

A. Body→Right ventricle → Right atrium → Left ventricle → Left atrium → Lungs.

B. Body → Right atrium → Left atrium → Lungs → Left ventricle → Left atrium.
C. Body → Right atrium → Right ventricle → Lungs → Left atrium → Left ventricle.
D. Body → Right ventricle → Right atrium → Lungs → Left ventricle → Left atrium.
E. Body → Right ventricle → Right atrium → Left ventricle → Lungs → Left atrium.

21. Where would you expect to find the highest levels of the following compound?

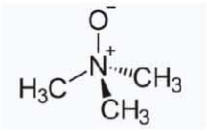


Figure 4: Compound. Credit: Wikipedia

A. Nasal duct of an albatross.
B. Loop of Henle of a kangaroo rat.
C. Peripheral blood of a nurse shark.
D. Malpighian tube of a queen ant.
E. Chorionic villus of a human fetus.

22. Infant botulism results from ingestion of *Clostridium botulinum* spores present in contaminated honey. This serious illness results in rapid onset of symmetric, bilateral, descending weakness beginning at the cranial nerves. Deep tendon reflexes become absent. Botulism is best described as a disorder featuring:

A. Upper motor neuron dysfunction.
B. Lower motor neuron dysfunction.
C. Peripheral polyneuropathy.
D. Blockade at the neuromuscular junction.
E. Diffuse muscle dysfunction.

23. Olivia was recently in a car crash. Her doctor took an fMRI and confirmed that there was peripheral vision loss. What part of her brain is damaged?

A. Prefrontal cortex.
B. Broca's area.
C. Wernicke's area.
D. Occipital lobe.
E. Medial geniculate nucleus

24. Basal metabolic rate is defined as the metabolic rate for an endotherm, an animal that produces its own body heat. Suppose a 1.8 kg newborn baby is born with a metabolic rate of 20 kcal/kg/day. What is the theoretical basal metabolic rate of the baby when it grows to 8.16 kg?

A. 11.11 kcal/day.
B. 36.00 kcal/day.

C. 95.00 kcal/day.
D. 154.8 kcal/day.
E. 162 kcal/day.

25. Gus was diagnosed with a tumor near his inner ear. After his doctor removed the tumor, Gus felt really dizzy climbing a ladder or while jumping. What part of his inner ear was most likely affected?
A. Utricle.
B. Saccule.
C. Semicircular canals.
D. Cochlea.
E. Tectorial membrane.

26. Judson is dissecting a barracuda, which is a marine bony fish. The barracuda's kidneys have which of the following functions?
I. Excreting excess water
II. Osmoregulation with major ions like Na^+ and Cl-
III. Excreting ions like Mg^{2+} and Ca^{2+}
A. I only.
B. III only.
C. I and II.
D. II and III.
E. I, II, and III.

27. You accidentally poke yourself with a rusted nail while moving out of your dorm. You suspect that the nail might be contaminated with various bacterial pathogens. Which of the following molecular events will MOST likely occur?
A. Immune cells will traffic to sites of inflammation via lymphatic vessels.
B. The complement system will be activated, which in turn can lead to opsonization and lysis of bacteria.
C. Adaptive lymphocytes will be the first cells to arrive, followed by monocytes/macrophages, then neutrophils.
D. The complement system will likely be activated, which in turn would expedite the generation of immune cells within the bone marrow.
E. When fluid containing clotting elements moves into a tissue, it will block the entry of immune cells and the resolution of inflammation begins.

28. Which of the following is TRUE about CD_4^+ lymphocytes?
A. They possess MHC class II receptors on their surface.
B. They mature in the lymph nodes.
C. They interact with antigen presenting cells via T cell receptors.

D. They possess both B and Toll-like receptors.
E. They are agranulocytes and mature in the bone marrow.

29. JARVIS is running a tonicity related experiment with the Avengers in his lab at 890, Fifth Avenue, Manhattan, New York City.

- Group 1 – Iron Man, Captain America and the Iron Patriot drink a liter of water.
- Group 2 – Black Widow, The Hulk and Doctor Strange drink a liter of coffee.
- Group 3 – Drax, Rocket and Groot drink a liter of concentrated salt solution.

The volume of urine produced by all individuals in the three groups is measured over a period of several hours. At the end of the monitoring period, which group above will have produced the greatest volume of urine and which group the least? Select from the alternatives provided below,

A. Those who drank coffee will produce the most urine, while those who drank water will produce the least.
B. Those who drank coffee will produce the most urine, while those who drank the salt solution will produce the least.
C. Those who drank the salt solution will produce the most urine, while those who drank water will produce the least.
D. Those who drank the salt solution will produce the most urine, while those who drank coffee will produce the least.
E. There will be no difference between the three groups.

30. Rac was walking through the desert for the past week, so he was drinking a lot less water than usual. Which of the following is a plausible way in which Rac's endocrine, excretory, and/or circulatory systems will respond to maintain homeostasis?

A. The posterior pituitary gland will secrete less antidiuretic hormone (ADH).
B. The walls of the heart atria will secrete more atrial natriuretic peptide (ANP).
C. The juxtaglomerular cells in the kidney's nephrons will secrete less renin.
D. The carotid baroreceptor (blood pressure receptor) reflex will trigger a sympathetic response that elevates heart rate and stroke volume.
E. The collecting ducts of the kidneys will excrete more sodium into the filtrate, causing a higher urine sodium concentration.

31. An ant population is placed inside a box with no food sources. Their behavior is disorganized and random. However, when a food source is placed at one end of the box, the ants form a line from each of their locations to the food source. This kind of behavior is mediated by:

A. Classical conditioning.
B. Pheromones.
C. Sensitization.
D. Operant conditioning.
E. Cultural learning.

32. Which of the following statements is FALSE about the referenced bird species learning to sing?

A. Both white-crowned sparrows and canaries engage in learning over multiple stages of their lives.
B. A young, white-crowned sparrow which does not hear music early in its life will not be able to learn its adult song.
C. A white-crowned sparrow's song is affected both by learning and by genetic preferences.
D. Young, white-crowned sparrows preferentially respond to unfamiliar songs over familiar songs to sharpen their own.
E. A canary's song is plastic in between breeding seasons and can be altered, while a white-crowned sparrow permanently crystallizes its song.

33. You are a marine biologist and ethologist fascinated by the environmental cues which regulate organismic behavior. You are working closely with fiddler crabs, which rely on environmental cues to regulate reproduction. To study the effects of environment on behavior, you take fiddler crabs from Bar Harbor, Maine and transplant them to a different beach. Which of the following environments would have the largest effect on their reproductive behavior?

A. A beach where tidal movement is much higher.
B. A beach where sunlight is more direct.
C. A beach where salinity is much lower.
D. A beach where nutrients are more available.
E. A beach with a much higher density of fiddler crabs.

34. Harry found a bunch of interesting plants growing in his backyard of varying heights. He recently learned about polygenic traits and additive genetics in his biology class. To test these theories, he crossed the tallest plant in his garden, which was 20 inches tall, with the shortest plant, which was 8 inches tall. All the F_1 offspring from this cross were 14 inches tall. Harry then crossed two F_1 plants, and the F_2 generation had the distribution of heights shown below. How many genes are responsible for determining the height of Harry's plants?

F2 Offspring Heights	**Frequency**
8 in	1
10 in	5
12 in	16
14 in	21
16 in	15
18 in	6
20 in	1

A. 1.
B. 2.
C. 3.
D. 4.
E. 5.

35. Abby is a calico cat who is heterozygous at an X-linked locus, where one allele specifies black

fur and the other specifies orange fur. Her mate, Vern, is white and has a null allele at that same locus. One member of the litter they produced was a rare black-and-orange male calico kitten. In which parent and in which division did nondisjunction occur?

A. Abby, first division.
B. Vern, first division.
C. Vern, second division.
D. Abby, second division.
E. Nondisjunction must have occurred in both parents, but the division is unknown.

36. You are studying a newly discovered gene that completely controls coat color in a certain species of mice whose individuals either have black or grey coats. To learn more, you perform three combinations of crosses between mice of specific coat colors and record the number of offspring by coat color. The results are aggregated and summarized in the table below.

Cross	**# Offspring with Black Coats**	**# Offspring with Grey Coats**
Black × Black	326	163
Black × Grey	247	259
Grey × Grey	0	503

Based on the results provided, which coat color is most likely to be the recessive phenotype, and which of the following terms most accurately describes the mode of inheritance we are observing?

A. Black mice are heterozygous.
B. Grey mice have a dominant allele for this trait on their mitochondria.
C. Male black mice have a recessive allele for this trait on their Y chromosome.
D. Male black mice have a recessive allele for this trait on their X chromosome.
E. Crossing a grey mouse from the Grey x Grey cross with a black mouse from the Black x Black cross would result in mostly grey mice.

37. Judson is studying the heredity of various traits in octopuses. First, he crosses a true breeding Blue Happy octopus with a true breeding Green Angry octopus and gets an F1 generation of 100% Blue Happy octopuses. When he crosses the F1 generation with itself, however, he gets the following offspring counts for each set of traits:

Phenotype	**Count**
Blue, Happy	70
Blue, Angry	6
Green, Happy	5
Green, Angry	19

If the Blue/Green gene and Happy/Angry gene are at two separate loci on the same chromosome, which of the following numbers is closest to the recombination frequency between these two genes?

A. 0.06.
B. 0.12.
C. 0.18.
D. 0.24.
E. 0.30.

38. Viral variants, such as influenza or SARS-CoV-2 variants that infect humans pose a major public health threat because they can weaken or evade immune responses. Such a variation exemplifies evolution by natural selection. Which of the following best describes how viral variants evolve?

A. Viruses survive and replicate themselves, just like cellular organisms.
B. Certain viruses, such as RNA viruses, have high natural rates of mutations, and are also subject to recombination events that alter their genetic sequence.
C. Some viruses evolve ways to infect cells and replicate independently of cellular mechanisms such as transcription or translation.
D. All types of viral variants arise by recombination when they jump between different host species.
E. Viral variants usually arise when viruses are exposed to antibiotics and become resistant.

39. Cats come in a large range of colors and patterns. One such pattern is known as tortoiseshell, in which X-linked inactivation causes apparent codominance, resulting in a mottled pattern of orange and black hairs. Can phenotypically male cats demonstrate a tortoiseshell or calico coloration?

A. Yes, but roughly 3/4 of cats demonstrating tortoiseshell coloration are expected to be female.
B. No, phenotypically male cats only have one X chromosome.
C. Yes, a small proportion of cats with XXY, mosaicism, or de la Chapelle (XX male) syndrome could display both male sex characteristics and mottled coloration.
D. Yes, a large proportion of cats have XXY, mosaicism, or de la Chapelle (XX male) syndrome could display both male sex characteristics and mottled coloration.
E. Yes, coat color is determined by the fetal environment before birth.

40. Greycen is a periwinkle farmer, and he is studying the inheritance of flower color in his periwinkles. There are two types of flower colors in periwinkles, blue and white, and he determined that two genes, A and B, are involved in determining this. In fact, a dominant allele in each gene is required for a periwinkle to be blue, otherwise the flower is white. If Greycen performs a dihybrid cross between two doubly heterozygous blue periwinkles, and picks a white flower at random from the offspring, what is the probability that this flower is homozygous recessive in both genes?

A. 1/16
B. 1/9
C. 1/8.
D. 1/7.
E. 1/3.

41. Which of the following best describes a trait that is acted on by negative frequency-dependent selection?

A. The color of mice in the Arctic.
B. The size of the tail feathers of male peacocks.
C. Mullerian mimicry between two species.
D. Aposematic coloration in poison dart frog.

E. Plant self-incompatibility genes.

42. Which of the following is an example of exaptation?

A. A dolphin flipper that shares a similar bone structure to a dog's leg.
B. A flying insect's wing that was originally used for thermoregulation.
C. A population of colorblind snakes on an isolated island which originated from two founders.
D. A non-poisonous dart frog that shares similar markings to a poisonous species.
E. An eyecup that develops from a pigmented patch of cells.

43. Dr. Zhao is studying a population of llamas using Hardy-Weinberg Equilibrium Principle. These llamas have a special gene that completely controls eye color, such that the dominant phenotypic trait is brown eye color, and the recessive phenotypic trait is blue eye color. There are initially 500 llamas, 480 of which have brown eyes and 20 with blue eyes. If, after 20 years, the llama population has expanded to a size of 2000 llamas while remaining in Hardy-Weinberg Equilibrium, how many llamas are expected to be heterozygous for the eye color gene?

A. 280.
B. 360.
C. 480.
D. 640.
E. 920.

44. What adaptation has occurred in species with limited access to water?

A. Modified gut contents.
B. Increased skin surface area.
C. Enlarged liver.
D. Longer loop of Henle in kidneys.
E. Reduced kidney size.

45. Plants are often ecologically grouped as either "sun plants" or "shade plants" based on their leaf morphology. Sun plants are adapted to gain maximal benefit out of high-intensity light while trying to avoid phototoxicity. Shade plants try to maximize gains from the low light intensity available. Which of the following is NOT a characteristic of a sun plant when compared to a shade plant?

A. Denser veins and chloroplasts.
B. More vertically angled leaves.
C. Larger leaves.
D. Thicker leaves.
E. More layered canopies.

46. Consider an area in which plants change from one group of species to another group of species

over a distance of 20 cm. How might this scale of variation affect two herbivores -- aphids (very small insects) and moose (large mammals)?

A. Aphids would be more strongly affected by this gradient.
B. Moose would be more strongly affected by this gradient.
C. Neither would be affected by this gradient.
D. They would be equally affected by this gradient.
E. Aphids would move faster over a 20 cm distance than moose.

47. In a population of butterflies under strong natural selection large wings are favored. If there is no genetic variation for wing size, what would one expect to occur in the next generation?

A. Wings will evolve to be smaller.
B. There will be no evolutionary change in wing size.
C. Wings will evolve to be more variable.
D. Wings will evolve to be larger.
E. There will be a strong differential success for wing size.

48. Some marine snails (Species L) produce large numbers of small eggs that are shed into the sea, hatch at an early stage of development, and feed on microscopic plants. Other marine snails (Species S) produce few eggs that are retained for a long time within the body of the mother snail in a brood pouch, hatch at an advanced stage of development, and immediately begin to feed on the surfaces of large plants like the adults. In the same area, over many generations, a biologist discovers approximately equal numbers of Species L and S adults. While studying the two species of snails, the biologist hypothesizes that the two species expend approximately the same amount of energy producing young. What assumption is the biologist making?

A. Species S snails could produce as many eggs as Species L snails under the same environmental conditions.
B. An egg of Species S contains more energy than an egg of Species L.
C. Since Species L snails produce more eggs, which may contain more energy.
D. Species S snails provide some energy to the young when they are in the brood pouch.
E. Species L snails produce broods that feed on different plant species.

49. For your biology research project, you wish to study the characteristics of pseudocoelomates. Which of the following phyla would be of most relevance to your research?

A. Nematoda.
B. Cnidaria.
C. Annelida.
D. Arthropoda.
E. Platyhelminthes.

50. You are walking in a forest when you stumble upon various fossils on the ground, shown below:



1. Credit: Forbes.com



3. Credit: Fossil Forum



5. Credit: Wikimedia / Commons

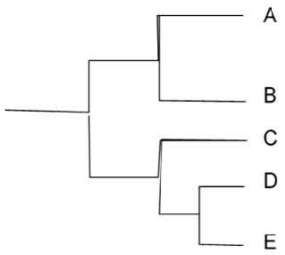


2. Credit: Google



4. Credit: Blogspot.com

Your friend Albert, a self-proclaimed paleontologist, begins to construct a phylogenetic tree (shown below) before passing out due to heat stroke. Oh no! It is now up to you to complete the tree. Which of the following answers A to E correctly matches these fossils to their position on the phylogenetic tree?



A. 1: A 2: B 3: C 4: D 5: E.
B. 1: C 2: E 3: A 4: B 5: D.
C. 1: C 2: E 3: A 4: D 5: B.
D. 1: A 2: E 3: C 4: D 5: B.
E. 1: A 2: E 3: B 4: C 5: D.