2025 USABO

1.If the leucine in position 39 of GG, a protein transporter, is mutated, what amino acid charged at physiological pH but still as similar as possible in size and shape to leucine would be the best substitute to use?
A. Asparagine.
B. Cysteine.
C. Glutamic acid.
D. Serine.
E. Proline.

2.Which condition would inhibit the pyruvate dehydrogenase complex (PDH)?
A. Ca2+
B. Elevated concentrations of acetyl-CoA.
C. Elevated concentrations of NAD+ and ADP
D. Elevated concentrations of NADH and ATP.
E. Insulin.

3.Where does FADH2 enter the electron transport chain?
A. Complex I.
B. Complex II.
C. Complex III.
D. Complex I and III.
E. Complex II and III.

4.Based on the chemical properties of fluorophores which image cells, which of the following structures will have the strongest light emission intensity upon excitation by ultraviolet light?

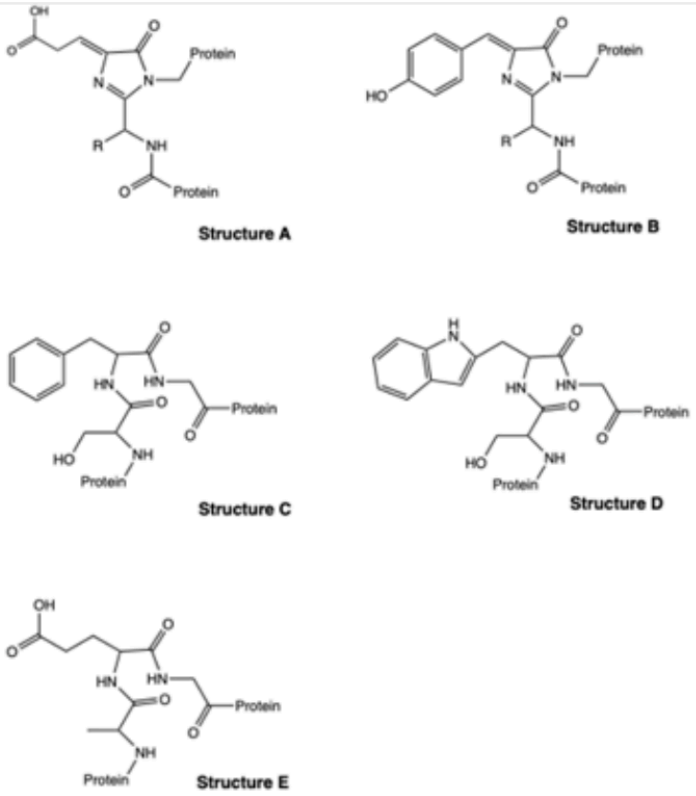

Figure 4. Molecular structures for light emission comparison. Author: Unknown.

A. Structure A.
B. Structure B.
C. Structure C.
D. Structure D.
E. Structure E.

5.In the linearized glucose structure below, how many stereoisomers of glucose are possible?

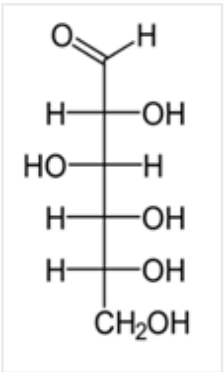

Figure 5. Linearized glucose structure. Source: Wikipedia.

A. 4.
B. 8.
C. 16.
D. 32.
E. 64.

6.In synthesizing the polypeptide sequence TEXTBOOKS. Consulting a codon

table, it was concluded that any sequence of the form "CCN GAR CGN CCN CAY UGY UGY AAY GAA" will work. (NOTE: A, C, G, and U represent adenine, cytosine, guanine, and uracil, respectively. N represents any of the 4 nucleotides, R represents purines, and Y represents pyrimidines.) How many possible sequences could synthesize TEXTBOOKS?
A. 512.
B. 1024.
C. 2048.
D. 4096.
E. 8192.

7.Which of the following statements regarding response pathways for endocrine signaling is TRUE?
A. Amine hormones may bind to receptors on the cell surface or in the cytoplasm or nucleus.
B. Lipid-soluble hormones bind to G protein-coupled receptors.
C. Peptide hormones require binding to transport proteins to reach target cells.
D. Steroid hormones are secreted by exocytosis.
E. Water-soluble hormones diffuse through the plasma membranes of target cells.

8.An organism has approximately 25,000 protein-coding genes. Assume the average weight of a protein in this organism is 70 kDa. The average weight of an amino acid is 120 Da.

Based on this information, what is the total length of the coding sequence in this organism’s genome, expressed in millions of base pairs (rounded to the nearest integer among choices)?
A. 35.
B. 40.
C. 45.
D. 55.
E. 60.

9.A new signaling pathway was discovered and named Capycoconut: Capybara ligand binds to the Coconut receptor, triggering a kinase cascade and translocation of the transcription factor Purple from the cytoplasm into the nucleus. Experimentation with a 60 phosphomimetic, replaces all serines on Purple with aspartic acids.
Which of the following results should he expect?
A. All Purple is expressed in the cytoplasm in the absence of Capybara, and all Purple is expressed in the nucleus in the presence of Capybara.
B. All Purple is expressed in the nucleus in the absence of Capybara, and all Purple is expressed in the nucleus in the presence of Capybara.
C. All Purple is expressed in the cytoplasm in the absence of Capybara, and all Purple is expressed in the cytoplasm in the presence of Capybara.
D. All Purple is expressed in the nucleus in the absence of Capybara, and all

Purple is expressed in the cytoplasm in the presence of Capybara.
E. Purple expression is uniform within the cell, regardless of the absence or presence of Capybara.

10.Which of the following modifications will increase hemoglobin's affinity for oxygen?
I. Altitude increases.
II. Blood CO_2 concentration increases.
III. Fetal hemoglobin present.
IV. Replacement of the Fe^{2+} in hemoglobin subunits with Fe^{3+}.
A. I, II.
B. I, III.
C. I, IV.
D. II,III.
E. II, III, IV.

11.Palindromes repeat the same letters forwards and backwards. A botanist is turning the sequence of flower whorls (from innermost to outermost) into palindromes.
According to the ABCDE model of flower development, which gene(s) should she delete?
A. B only.
B. C only.
C. D only.
D. B and D.
E. C and D.

12.Which of the following ingredients in an Everything Bagel does not come from a monocot?
Caraway seeds.
A. Caraway seeds
B. Cornmeal.
C. Garlic Flakes.
D. Onion flakes.
E. Wheat flour.

13.What metabolic system allows for the conversion of acetyl-CoA into carbohydrates within plants?
A. Citric acid cycle.
B. Calvin cycle.
C. Glyoxylate cycle.
D. Glycolysis.
E. Pentose phosphate pathway.

14.Which one of the following is a correct Sequence of processes that take place when a flowering plant reproduces?
A. Meiosis-> Fertilization-> Ovulation-> Germination

B. Fertilization-> Meiosis-> Nuclear fusion-> Formation of endosperm
C. Meiosis-> Pollination-> Nuclear fusion-> Formation of embryo and endosperm
D. Growth of pollen tube-> Pollination-> Germination-> Fertilization
E. Meiosis-> Mitosis -> Nuclear fusion- Pollination

15.Which plant hormone is synthesized primarily in roots and transported to other organs, playing a key role in regulating cell division in shoots and roots?
A. Abscisic acid.
B. Auxin.
C. Cytokinins.
D. Ethylene.
E. Gibberellins.

16.A farmer wants to prevent premature seed germination in crops during unexpected warm spells. Which plant hormone should be focused on increasing to inhibit early germination and promote seed dormancy?
A. Abscisic acid.
B. Brassinosteroids.
C. Ethylene.
D. Gibberellins.
E. Jasmonotes.

17.Which of the following accurately describes a key difference between tracheids and vessel elements in vascular plants?
A. A Both tracheids and vessel elements lack lignified secondary walls.
B. Tracheids are alive at functional maturity, whereas vessel elements are dead.
C. Tracheids are found only in angiosperms, while vessel clement are present in all vascular plants.
D. Tracheids are generally wider and shorter than vessel elements.
E. Water moves through pits in tracheids but through perforation plates in vessel elements.

18.You are interested in plant responses to external stimuli. You find a plant that will flower if its light period is longer than 13 hours. Which of the following statements is/are TRUE?
I. Absorption maximum of the Pr form of plant phytochromes is near 480 nm.
II. During the 12-hour night period, you administer a flash of red light followed by far red light. The plant will flower.
III. If you remove the chromophore from the phytochrome apoprotein, the plant will never flower.
IV. The hormone that mediates flowering likely moves through the plant via plasmodesmata.
A. I, II.
B. I, II, III.
C. II, IV.
D. III, IV.

E. II, III, IV.

19.Which organism does NOT possess a structure made of calcium carbonate?
A. Barnacle
B. Cuttlefish.
C. Foram.
D. Oyster.
E. Porifera.

20.Which of the following is NOT an ectoderm derivative?
A. Adrenal medulla.
B. Melanocyte.
C. Respiratory epithelium.
D. Spinal cord.
E. Sweat gland.

21.Chronic metabolic acidosis is a condition where there is a persistent increase in blood acidity. This may be caused by untreated diabetes due to the excessive production of ketoacids.
Which of the following is NOT a way that the body can respond to this pH disturbance?
A. Decrease in bone mineral density.
B. Decrease NH3 production in the renal tubules.
C. More rapid breathing.
D. Increased H+ excretion.
E. Reduction in CO2 partial pressure in the blood.

22.Natural killer (NK) cells and cytotoxic T cells are both immune cell types that can kill abnormal human cells in the body like virus-infected or cancer cells.
Which of the following is a MAJOR difference between these immune cell types?
A. Cytotoxic T-cells use antigen-presentation via MC class II (class two) molecules as a primary pathway of activation, whereas NK cells do not.
B. Cytotoxic T cells usually operate with the assistance of antibodies, whereas NK cells do not.
C. NK cells will readily kill cells with low surface MC class I (class one) surface levels, while cytotoxic T cells will not.
D. NK cells largely target virus-infected cells, while cytotoxic T cells target both virus-infected and cancer cells.
E. NK cells usually function near epithelia, whereas cytotoxic T cells usually circulate in the bloodstream.

23.Human chromosomes and mitochondrial chromosomes differ most in WHICH of the following?
A. Codon usage.
B. Copy number per cell.
C. Degree of methylation.

D. Relative proportions of A, T, G, and C.
E. Turns per base pair.

24.Fish living in a freshwater environment have a higher internal ion concentration than the water around them. Since the gills of fish are permeable to both ions and water (the gills are also a primary site of ion regulation), maintaining appropriate ion and water balance is a constant battle for these fish. Which of the following would be TRUE of water and ion flux in a freshwater fish?
A. Ions are actively excreted by the gills
B. Ions passively enter the fish via the gills.
C.Ions passively leave the fish via the gills.
D. Little water is excreted in urine.
E. Water passively leaves the fish via the gills.

25.Which of the following will increase conduction speed along an axon?
A. Decreasing the diameter of the myelin sheath.
B. Higher axon length.
C. Larger axon diameter.
D. Lower axon temperature.
E. Lower dendrite number.

26.Which of the following signaling mechanisms pass a signal from one cell to another fastest?
A. Endocrine.
B. Gap junction.
C. Juxtacrine.
D. Paracrine.
E. Synaptic neurotransmitter.

27.Which cells in the stomach secrete intrinsic factor, a glycoprotein essential for absorption of vitamin B12?
A. Chief cells
B. G cells.
C. Enterochromaffin-like
D. Mucous neck cells.
E. Parietal cells.

28.You are interested in Graves' disease, a condition in which autoantibodies bind to the receptors for TSH on thyroid gland cells. Which of the following potential medications could treat this condition?
A. Administration of an enzyme that catalyzes peripheral conversion of T4 to T3.
B. Administration of an iodotyrosine coupling inhibitor.
C. Hematopoietic stem cell transplantation.
D. Life-long thyroid hormone replacement.
E. Prophylactic IgG replacement therapy.

29.Which of the following factors has contributed to the rising cases of West Nile virus infections in the United States in recent years?
A. Altered precipitation patterns.
B. Higher transmission rates through person-to-person contact.
C. Increased vaccination rates for West Nile virus.
D. Improved diagnostic tools lead to better case detection.
E. Mosquitoes carry the highest amounts of the virus in the late summer and early fall is the leading cause.

30.In the diagram below, three vessels (X, Y, Z) are connected, and the relative resistances (R) of these vessels are provided.

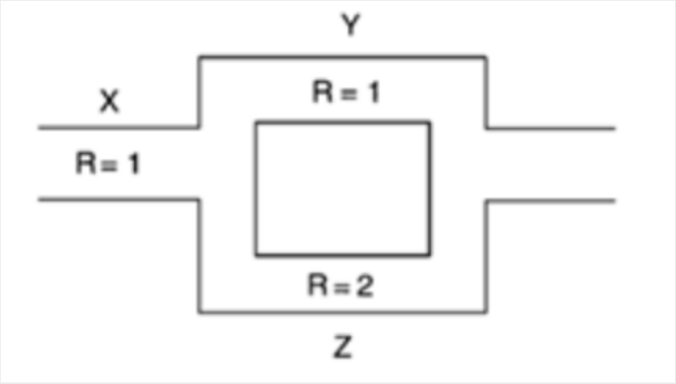

Figure 30. Diagram of three connected ressels. Aulor: Atahan Durbas.
What is the ratio of the flow in vessel X (m1/min) to the flow in vessel Y?
A. 1:1
B. 2:1
C. 3:1
D. 3:2
E. 4:3

31.If you were to arrange the following steps in gene cloning order, Which step would be third?
A. A cDNA copy of mRNA is made using reverse transcriptase and the DNA strand is replicated.
B. The plasmid is inserted into the bacterial host cell.
C. mRNA molecules coding for the desired product are isolated.
D. Restriction end nucleases are used to cut DNA, producing sticky ends.
E. The plasmid DNA and the clone gene are joined and sealed by ligase.

32.Chef Piero is preparing a delicious pizza for a fussy client. His client has a very peculiar palate, and prefers foods that are high in DNA content per cell. Which of the following foods should Chef Grace use in the pizza?
A. Anchovies.
B. Fiddlehead ferns.
C. Kiwis.
D. Ground beef.
E. Portobello mushrooms.

33.Difficulty in extending the bacterial operon mod to developing eukaryotes lies in
A. Differences in processing the transcriptional message.
B. Preference for animals to use glucose instead of lactose.
C. Genes for related functions assembled for different polypeptides in the individualized protein located on different chromosomes.
D. Operons that are not all inducible in nature.
E. The use of different RNA polymerases in bacteria and eukaryote.

34.The genes for fluffiness and shininess are linked in Pachirisu. The alleles for fluffiness are f+ (fluffy) and f (bare), and those for shininess are b+ (bare) and b (shiny). You perform a testcross with a Pachirisu that is heterozygous for both fluffiness and shininess and obtain the following results:

Phenotype	Number of Offspring
fluffy-shiny	453
bare-dull	470
fluffy-dull	67
bare-shiny	68

Table 34. Phenotypic table of test cross of Pectinia. Author: F. Li.

What is the recombination frequency for the fluffiness and shininess genes in Pachirisu?
A. 7.56%
B. 12.8%
C. 14.6%
D. 85.4%
E. 87.2%

35.Vivian is interested in quantifying tissue-specific mRNA expression associated with the condition Odell. She has identified two enhancers whose expression is correlated with Odell, but she still does not know the sequence of the gene that directly causes Odell. Which of the Ususna following techniques could she NOT use to identify differentially regulated genes associated with Odell?
A. ATAC-sequencing,
B. Bulk RNA sequencing.
C. ChIP-sequencing.
D. CRISPRi-medinted genome targeting.
E. Fluorescence in-situ hybridization.

36.Which of the following statements correctly explains the DIFFERENCE between translation in bacteria and eukaryotes?
A. Multiple ribosomes in eukaryotes cannot translate a single mRNA

simultaneously, while this occurs in bacteria.
B. The start codon in bacterial translation is different from the one used in eukaryotes.
C. Transcription and translation can be coupled in bacteria, while eukaryotes cannot be due to compartmental organization.
D. Translation in bacteria occurs in the nucleus, while in eukaryotes, it occurs in the cytoplasm.
E. Translation in bacteria uses polyribosomes, while eukaryotes do not form polyribosomes.

37.Which of the following is an example of mechanical isolation acting as a prezygotic reproductive barrier between species?
A. Hybrids of two plant species produce sterile offspring in the next generation.
B. Sperm of one sea urchin species cannot fertilize the eggs of another species due to incompatible surface proteins.
C. Two species of birds have different courtship dances that are not recognized by each other.
D. Two species of frogs breed at different times of the year, preventing them from mating,
E. Two species of snails have shells that spiral in opposite directions, preventing mating alignment.

38.A scientist observes that cells treated with a specific inhibitor are unable to cleave cohesin proteins holding sister chromatids together. Consequently, the sister chromatids do not separate, and the cell cycle halts at a specific phase. At which phase of mitosis does this arrest own most likely occur due to the inability to separate sister chromatids?
A. Anaphase.
B. Cytokinesis.
C. Metaphase.
D. Prophuse.
E. Telophase.

39.In a population of ground squirrels, an individual notices an approaching predator. By giving an alarm call, the squirrel can warn a single relative, increasing that relative's chance of survival. However, by doing so, the caller increases its own risk of predation, reducing its expected number of offspring by 0.5 (cost C=0.5). The benefit to the relative is an increase of 1.5 in their expected number of offspring (benefit B=1.5).
According to Hamilton's rule, natural selection will favor the altruistic act when the relative is:
A. A cousin.
B. A half-sibling.
C. A full sibling.
D. A nephew.
E. An unrelated individual.

40.Genes A and B are 10 unis apart on the same chromosome. individuals homozygous dominant for these genes are mated with homozygous recessives. The offspring are test- crossed. If there are 1000 offspring from the test cross, how many offspring would be expected to show crossover phenotypes?
A. 10
B. 50
C. 100
D. 250
E. 500

41.

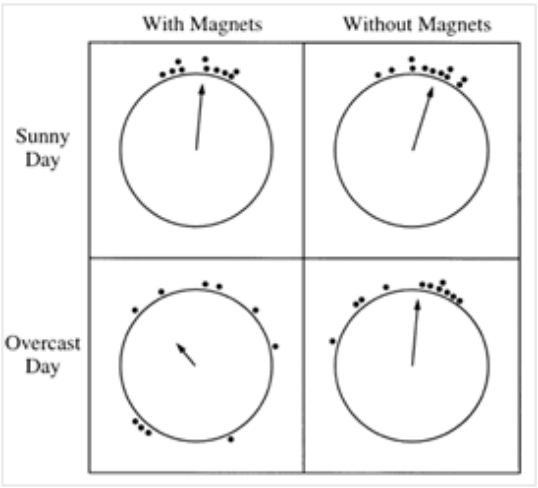

Figure 41. Diagram of homing pigeon flight in relation to magnetism and light. Author: Unknown.
In the diagram above, the center of each circle represents the location at which homing pigeons were released. The top of each circle is the homeward direction, each dot represents the direction taken by one bird, and the arrows represent the statistical average of the chosen directions. The birds in the left-hand circles were equipped with magnets that prevented them from detecting the Earth's magnetic field.
This experiment demonstrated that homing pigeons
A. Lose navigational ability when magnets are attached to them.
B. Navigate only on sunny days.
C. Use only the Sun as a compass for navigation.
D. Use only the Earth's magnetic field for navigation.
E. Use either the Sun or the Earth's magnetic field as navigational aids.

42.The prairie dog, a rodent genus from the Sciuridae family, is native to the grasslands of North America. When a sentinel prairie dog observes an eagle flying overhead, it gives an alarm call to warn other members of the prairie dog community who are foraging for food.
Which of the following concepts best explains this behavior?
A. Agonistic Behavior.
B. Altruism.
C. Imprinting.

D. Instinctive Behavior.
E. Operant Conditioning.

43.Which of the following scenarios is an example of the bottleneck effect in a population?
A. A small group of birds migrates to a new island and establishes a new population with different allele frequencies than the original population.
B. Individuals from one population of flowers pollinate another population, introducing new alleles and reducing genetic differences between them.
C. Mutations introduce a new allele into a population, slowly increasing its frequency over many generations.
D. Predators preferentially prey on individuals with a certain phenotype, increasing the frequency of a beneficial allele over time.
E. The decline of the northern elephant seal population in the 1890s.

44.The average net productivity of open ocean and of tundra are roughly equal to each other and are each about 150 g/m2/yr. The Earth has more open ocean than it has tundra. From this information you would predict that:
A. Added together the open oceans and tundra of the Earth produce 300 g/yr of biomass.
B. Less of the Earth's net primary production is from open ocean than from tundra.
C. Added together the open oceans and tundra of the Earth produce 150 g/yr of biomass.
D. More of the Earth's net primary production is from open ocean than from tundra.
E. An equal amount of the Earth's net primary production is from open ocean and from tundra.

45.The moss Lewinskya affinis grows on trees, but does not depend on the tree for nutrients. What kind of symbiotic relationship does the moss have with the trees it grows on, and what kind of plant can the moss be classified as?
A. Amensalism; Epiphyte.
B. Amensalism; Saprophyte
C. Commensalism; Epiphyte.
D. Mutualism: Parasite.
E. Parasitism; Parasite.

46.Below is a hypothetical life table for squirrels in Cambridge, MA. Which type of survivorship curve would this correlate to?

Age (years)	Number Alive
0	1000
1	920
2	846
3	778
4	716
5	659

Table 46. Hypothetical life table for squirrels in Cambridge, MA. Author: F. Li.

A. Type I.
B. Type II.
C. Type III.
D. Stair-step.
E. None of the above.

47.Several types of animal species reproduce solely through asexual reproduction. Which of the groups below is NOT among these groups?
A. Fish.
B. Flies.
C. Frogs.
D. Lizards.
E. Rotifers.

48.*Symbion pandora* are microscopic cyliophorans that live on the mouthparts of Norway Lobsters and feed on the lobsters' leftovers. The lobster appears unaffected by this phenomenon. This is an example of...
A. Amensalism.
B. Commensalism.
C. Mutualism.
D. Neutralism.
E. Parasitism.

49.For a biosystematics-themed dinner party, you have decided to bring a fungi flatbread made only with organisms that produce spores in sac-like spaces. Which of the following fungi can you use, and what phylum does it belong to?
A. Corn smut, Ascomycota.
B. Cremini, Basidiomycota.
C. Maitake, Basidiomycota.
D. Morel, Basidiomycota.
E. White mushroom, Basidiomycota.

50.Which of the following correctly lists the following animals from most closely to least closely related to planarians?

I. Caenorhabditis (roundworm).
II. Holothuria (sea cucumber).
III. Octopus (octopus).
IV. Schistosoma (blood fluke).
A. II, I, II.
B. II, I, III, IV.
C. I, II, III, IV.
D. I, III, IV, II.
E. IV, III, I, II.