Biology Diagnostic

Everaise Academy

2021

Below is a diagnostic to test whether the student is ready for Everaise Academy's Biology course. Everaise Academy is not collecting your scores on this test; it is only for your personal use. Instructions are as follows.

- The student should attempt every problem below without randomly guessing, a time limit, or tools including outside help or a calculator unless otherwise specified.
- After the student has made their best possible attempt, check their answers against the answer key attached at the bottom of this PDF.
- Tally each section.

This test serves as a diagnostic for you to make a more informed decision about which two subjects you would like to take for this summer. Logically, the two lowest scoring sections would be your priority but the decision is up to you.

Cell Biology & Biochemistry

1. Which amino acid would you most likely find in the protein core of a globular protein?

   (a) Arginine

   (b) Isoleucine

   (c) Serine

   (d) Glutamic Acid

   (e) Asparagine

2. Which of the following organelles has a double membrane?

   (a) Chloroplast

   (b) Golgi Apparatus

   (c) Lysosome

   (d) Vacuole

   (e) Ribosome

3. Which of the following is used mainly for separating proteins?

   (a) Southern Blot

   (b) Western Blot

   (c) Northern Blot

   (d) Eastern Blot

   (e) Nitrocellulose

4. Which of the following is false about myosins?

   (a) They are Mg^{2+}-dependent ATPases.

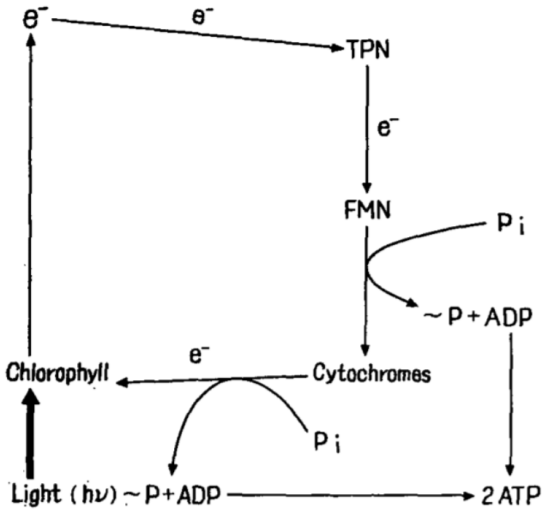
   (b) Unconventional myosins are present in almost every eukaryotic cell.

   (c) The most evolutionary conserved part is the section of the head domain that binds ATP.

   (d) There are multiple myosin classes in Prokaryotes.

   (e) They are involved in intracellular transport.

5. Flavin mononucleotide, or FMN for short, mediates the electron transport between the reduced form of DPN and oxygen in the respiratory reaction. In chloroplasts, it is known to stimulate photosynthetic phosphorylation. The following pathway shows photophosphorylation in *Chromatium*. Which of the following is false regarding this pathway?



(a) This pathway is a form of cyclic photophosphorylation.

(b) Chlorophyll absorbs a photon of light and then expels a high energy-level electron.

(c) ATP is formed from ADP and pyrophosphate.

(d) The high-potential electron is captured by TPN and then transferred to FMN.

(e) Triphosphopyridine nucleotide, TPN, gets reduced in this process.

6. Consider the following experiment: plants are placed into test tubes filled with water. The test tubes are then sealed and the atmosphere of each tube is saturated with carbon dioxide. After leaving the plants in different conditions overnight, the researcher adds bromothymol blue, a pH indicator which turns yellow under acidic conditions, to the water. By doing this, the researcher hopes to gain knowledge about which plants are doing photosynthesis under different conditions. Under which conditions would the researcher expect the indicator to turn yellow?

(a) Tube is left under white light

(b) Tube is left under blue light

(c) Tube is left under green light

(d) Tube is left in the dark

(e) Two of the above

7. In addition to the treatment group in the previous question, the researcher also adds a second compound which catalyzes the reaction NADPH→$NADP^+$ as well as ATP→ADP. After leaving this new tube under white light overnight, the researcher finds that the seal on this test tube has ruptured! What is the most plausible explanation?

   (a) The plant started over-producing CO_2.

   (b) The plant consumed too much CO_2 without producing O_2, causing the pressure inside the tube to drop.

   (c) The light-dependent reactions of photosynthesis were able to continue, allowing production of O_2 without the consumption of CO_2.

   (d) The plant consumed too much H_2O, which caused dissolved gases to escape into the atmosphere of the tube, eventually building up and causing the seal to rupture.

   (e) Sometimes, science just doesn't work right.

8. The researcher also wants to test a bacterial toxin that creates pores in the stroma membrane. The researcher adds the toxin to the test tube with a plant in it and then leaves the tube under white light overnight. When the researcher adds the bromothymol blue indicator the next morning, the researcher finds that the indicator turns yellow. Why is this so?

   (a) The toxin prevents chlorophyll from absorbing light.

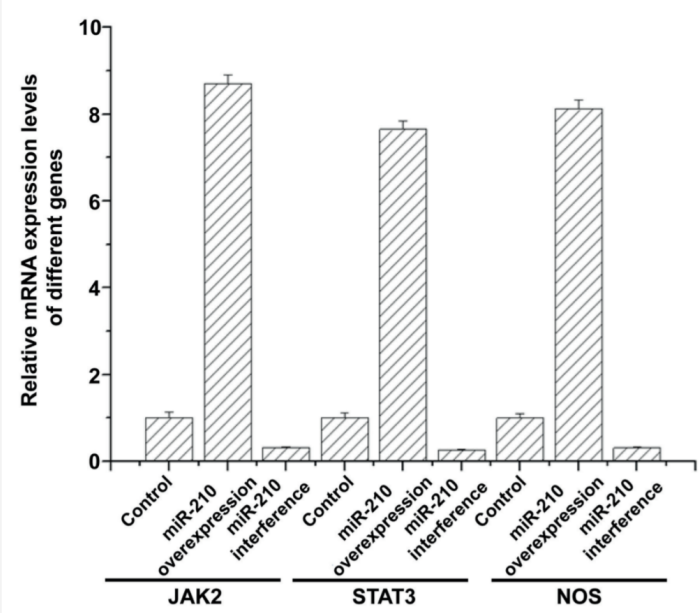
   (b) The toxin stops the reaction $NADP^+$→NADPH, halting photosynthesis.

   (c) The toxin causes peripheral membrane proteins such as plastocyanin to flood into the chloroplast, disrupting photosynthesis.

   (d) The toxin prevents the formation of a proton gradient, disallowing ATP production.

   (e) None of the above.

9. Arteriosclerosis obliterans (ASO) is a kind of common peripheral arterial occlusive disease. Other results show that miR-210 may have a correlation with ASO. Scientists wanted to learn the relationship between the miR-210 and the JAK-STAT signalling pathway. Cell lines with miR-210 overexpression and interference were constructed with different genes and their transcriptional levels. Which of the following is true?



(a) JAK2, STAT3, and NOS gene transcriptional levels declined in cell lines with miR-210 interference compared with those in the control group.

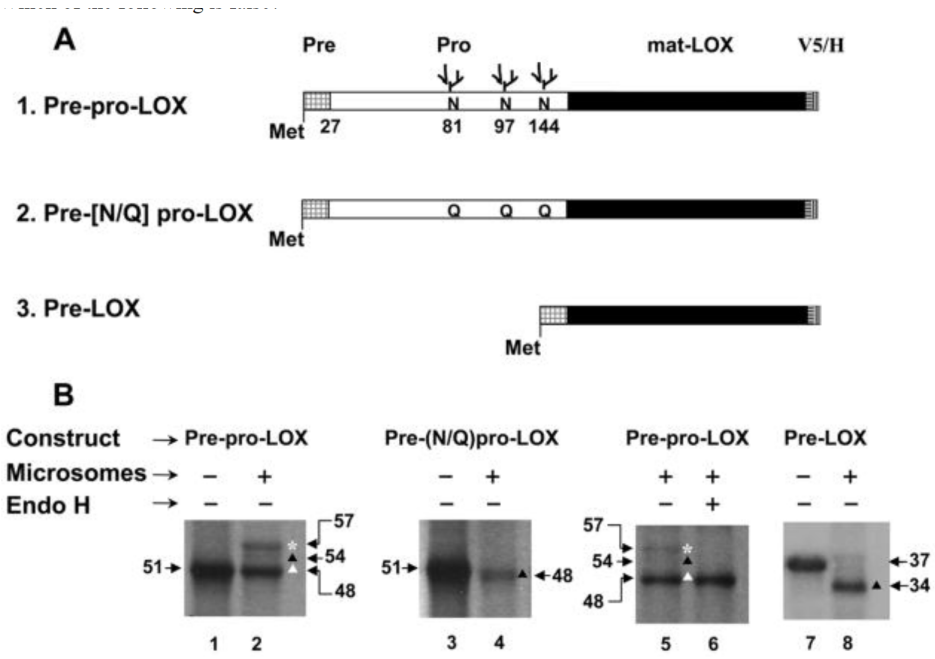
(b) The JAK2, STAT3, and NOS gene transcriptional levels were decreased in cell lines with miR-210 overexpression compared with those in the control group.

(c) Up-regulation of miR-210 expression can inhibit the JAK2, STAT3, and NOS gene transcription.

(d) Down-regulation of miR-210 expression can promote the JAK2, STAT, and NOS gene transcription.

(e) The transcriptional levels can not be detected by fluorescence qPCR.

10. Lysyl oxidase (LOX) is secreted as a proenzyme (proLOX) that is proteolytically processed in the extracellular milieu to release the propeptide and mature, active LOX. The LOX propeptide (LOX-PP) is glycosylated. Full-length LOX cDNA (pre-pro-LOX), the N-glycosylation null pre-[N/Q]pro-LOX cDNA and the deletion mutant pre-LOX cDNA, referred to as secretory LOX, in which mature LOX is targeted to the secretory pathway without its N-terminal propeptide sequence are the three peptides in the diagram. Which of the following is false?



(a) Pre-pro-LOX includes the complete open reading frame of human lysyl oxidase and encodes the signal sequence.

(b) The 54 kDa and 57 kDa bands are the pro-LOX and triple-glycosylated pre-pro-LOX respectively.

(c) The 37 kDa and 34 kDa bands are mat-LOX and pre-LOX respectively.

(d) The 51 kDa and 48 kDa bands are the non-glycosylated pre-pro-LOX and pro-LOX respectively.

(e) The asparagine residues of the three predicted N-glycosylation sites within the propeptide domain of pre-pro-LOX were mutated to glutamine residues to generate the N-glycosylation-null mutant construct.

Animal Anatomy & Physiology

1. Which of the following hormones is mismatched with one of its sources?

   (a) Insulin - Intestines

   (b) Testosterone - Testes

   (c) Ghrelin - Stomach

   (d) Growth Hormone - Pituitary Gland

   (e) hCG - Placenta

2. Choose the correct order of the steps of a neural reflex.

   I. Arrival of stimulus and activation of receptor

   II. Activation of motor neuron

   III. Response of peripheral effector

   IV. Information processing by postsynaptic cell

   V. Activation of sensory neuron

   (a) I, V, III, IV, II

   (b) V, I, II, IV, III

   (c) I, III, IV, V, II

   (d) V, IV, II, I, III

   (e) I, V, IV, II, III

3. Which tissue is responsible for red blood cell production?

   (a) Kidney

   (b) Spleen

   (c) Brain

   (d) Heart

   (e) Bone Marrow

4. Which of the following is true about the differences or similarities between the relative oxygen affinities of hemoglobin and myoglobin?

   (a) Myoglobin has a greater oxygen affinity than hemoglobin.

   (b) Hemoglobin has a greater oxygen affinity than myoglobin.

   (c) Both have roughly the same oxygen affinity.

   (d) Neither has a significant oxygen affinity.

   (e) The two cannot be compared as one is associated with binding the other with storage.

5. Which of the following is not true about skeletal muscle?

   (a) The length (distance) of a single muscle contraction depends on the concentration of Ca^{2+} ions in the sarcoplasmic reticulum.

   (b) Muscles with short sarcomeres contract faster than muscles with long sarcomeres.

   (c) The velocity of muscle contractions is determined by myosin-ATPase activity.

   (d) Tetanus is the effect of repeated stimulations within a very short interval.

   (e) Rigor mortis appears when the Ca^{2+} concentration in cytoplasm is high, but ATP lacks.

6. When blood pressure is low, which is the best description of response in the renal arterioles?

   (a) Construction of afferent arterioles, dilation of efferent arterioles

   (b) Constriction of both afferent and efferent arterioles

   (c) Dilation of afferent, constriction of efferent arterioles

   (d) Dilation of both afferent and efferent arterioles

   (e) None of the above

7. A patient with a hypothalamic tumor has hypersecretion of ADH. Which of the following BP readings would be most likely for this patient?

   (a) 95/65

   (b) 115/80

   (c) 120/60

   (d) 165/100

   (e) No change in BP

8. Which of the following is not an effect of TSH on the thyroid gland?

   (a) Increased proteolysis of the thyroglobulin

   (b) Increased intake of iodide

   (c) Increased iodination of tyrosine

   (d) Increased size and increased secretory activity of the thyroid cells

   (e) Change from columnar to cuboidal thyroid cells

9. An experiment was designed to determine the rate of renal excretion of vitamin Bronana, a B-vitamin that is freely filtered, partially reabsorbed, and not secreted. Tian, a human-subject, after large doses of vitamin Bronana, showed plasma concentration of the vitamin of 20 mg/L. The vitamin Bronana clearance was determined to be 80 ml/min. The rate of urine flow is 5 ml/min and the urinary concentration of inulin is 20 mg/ml while the arterial plasma inulin concentration is 1 mg/ml. Which of the following is false?

   (a) The excretion rate of vitamin Bronana is 1.6 mg/min.

   (b) The GFR is 100 ml/min.

   (c) The reabsorption rate of the vitamin in the tubules is 8.4 mg/min.

   (d) The renal venous concentration of inulin is 1 mg/ml.

   (e) If vitamin Bronana had a similar structure to thiamine then it could be used in chelation therapy.

10. Which of the following is false concerning the retinoid cycle?

    (a) Upon photon absorption, the retinal is converted to an all-trans retinal.

    (b) Rhodopsin kinase phosphorylates the activated rhodopsin which allows arrestin to bind to rhodopsin.

    (c) Arrestin blocks the phototransduction cascade.

    (d) All-trans retinal is transported to the pigment epithelium by IRBP.

    (e) PDE hydrolyzes cGMP at the disk membrane.

Plant Anatomy & Physiology

1. Most plant water loss happens through which structure?

   (a) Roots

   (b) Stem

   (c) Stomata

   (d) Trichomes

   (e) Pits

2. Which of the following is not a plant macronutrient?

   (a) Carbon

   (b) Oxygen

   (c) Nitrogen

   (d) Magnesium

   (e) Chlorine

3. Which organism is least likely to be involved in flower pollination?

   (a) Bees

   (b) Flies

   (c) Hummingbirds

   (d) Moths

   (e) Bears

4. Which specific type of cells that help transport water in the xylem of vascular plants, have lignified walls, and have perforations at their end plates?

   (a) Parenchyma

   (b) Collenchyma

   (c) Sclerenchyma

   (d) Tracheids

   (e) Vessel Elements

5. Which of the following is not true of actin in plants?

   (a) Functions as a track for the transport of vesicles

   (b) Fluctuation in auxin content has regulatory features on actin organization

   (c) The actin-depleted zone formed after the breakdown of the nuclear envelope becomes the site of the prospective cell plate.

   (d) Cytochalasin B, an actin inhibitor, can block nuclear migration.

   (e) Integrins link the actin filaments to extracellular binding sites.

6. Plant invaders are often morphologically and physiologically adapted to be a superior competitor over a native species. Which of the following is not an advantage that invaders have?

   (a) Mass seed production

   (b) High growth rate

   (c) High ecological plasticity

   (d) Allocation of resources to meristematic tissue

   (e) High photosynthetic capacity

7. Which of the following is true of C4 plants but not C3 plants?

   (a) Photosynthesis occurs in both mesophyll and bundle sheath cells.

   (b) Kranz anatomy is absent.

   (c) Photorespiratory loss is high.

   (d) The carbon dioxide acceptor is Rubsico.

   (e) Cotton is a C4 plant.

8. Which of the following plant hormones is incorrectly matched with one of its functions?

   (a) Auxin - stimulate ethylene synthesis

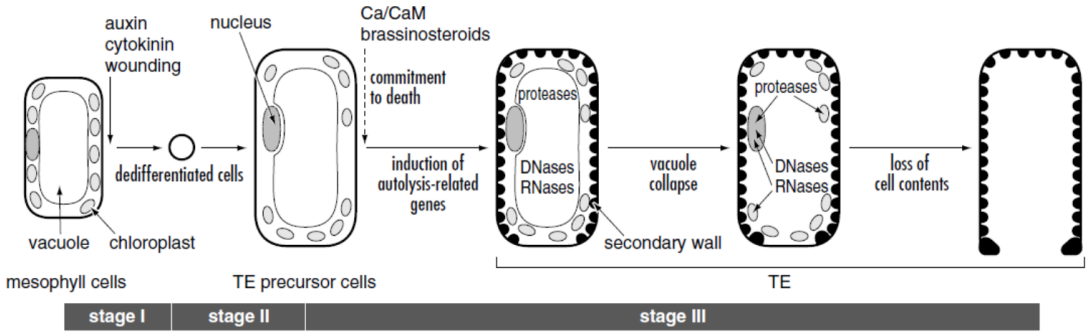
   (b) Cytokinin - promote cell division

   (c) Ethylene - fruit abscission

   (d) ABA - stomatal closure

   (e) Gibberellin - inhibition of seed germination

9. The following diagram shows a model for tracheary element differentiation. Which of the following is false about this model?



(a) The result is a mature tracheary element with a perforation at one end.

(b) Stage II has a markedly increase in transcription of genes that encode components of the protein synthesis apparatus.

(c) During stage I, formation of thick actin cables function in cytoplasmic streaming.

(d) Collapse of the central vacuole begins with completion of secondary wall formation.

(e) If the process was seen under a fluorescence microscope, we would expect to see increasing intensity due to lignin autofluorescence.

10. The direct effects of increased CO_2 concentrations on crop nutrient use and crop productivity are significantly positive, quantified on different types of crops, but there are also negatives as well. Which of the following is not true of the effects of elevated CO_2 on crops?

(a) Elevated CO_2 can diminish crop leaf stomatal activity to reduce water use.

(b) High CO_2 concentrations could inhibit the assimilation of nitrate in grain crop.

(c) Elevated CO_2 reduces stomatal and metabolic limitations on photosynthesis under salinity conditions.

(d) Elevated CO_2 transported in xylem sap can be fixed in photosynthetic cells in plant leaves and branches to enhance C assimilation.

(e) None of the above

Genetics & Evolution

1. Which of the following best describes DNA replication?

   (a) Conservative

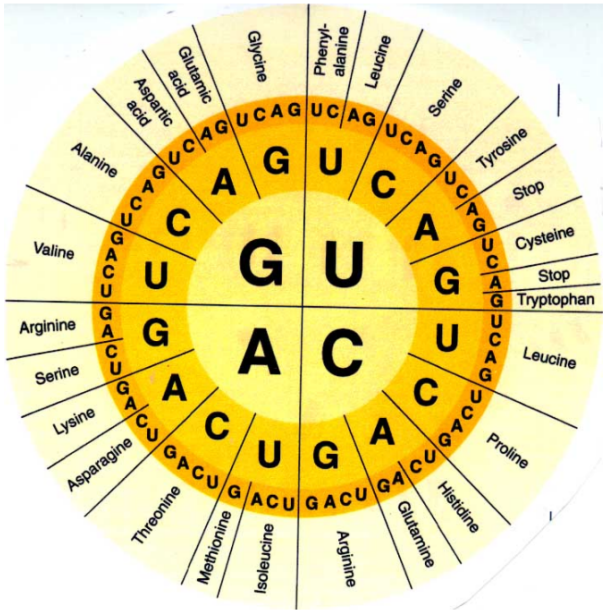
   (b) Semi-conservative

   (c) Dispersive

   (d) Transcription

   (e) Rho-dependent termination

2. Which of the following amino acids would the codon, AAA, translate into?



   (a) Glutamic Acid

   (b) Stop

   (c) Lysine

   (d) Threonine

   (e) Serine

3. The trait, scholar, is inherited in a normal dominant-recessive manner. The trait scholar is recessive to the trait, non scholar, which is dominant. If a homozygous scholar is bred with a homozygous non scholar, what is the phenotypic ratio of the offspring.

   (a) All scholar

   (b) All non scholar

   (c) Half scholar, half non scholar

   (d) Mostly scholar

   (e) Mostly non scholar

4. Assume that all of the offspring from the previous question form a population and meet the requirements for Hardy-Weinberg equilibrium. After many many generations, what would be the percent of heterozygous individuals in the population for the scholar trait?

   (a) 0%

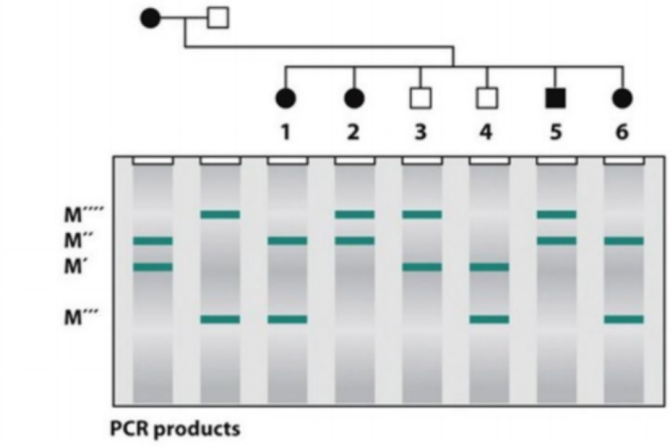
   (b) 33%

   (c) 50%

   (d) 75%

   (e) 100%

5. The figure below includes a pedigree for a family with a heritable genetic condition, and a gel electrophoresis revealing PCR genotypes for a molecular marker. This molecular marker has alleles which differ in their number of tandem dinucleotide repeats (repeat lengths of 2 base pairs). Each gel lane (column) refers to the genotype for the individual directly above in the pedigree. What type of molecular marker was used and if any, which marker is linked with the trait?



(a) Microsatellite; No link

(b) Microsatellite; M'

(c) Microsatellite; M"

(d) SNP; M"

(e) SNP; M""

6. Dancing skills are tied to a gene called LISA, and singing skills are attributed to a gene called ROSE. Both genes are autosomal dominant for the wild type alleles (proficiency at dancing and singing), and are located 50 centimorgans apart on the same chromosome. Carl is heterozygous at both loci, while his mom and dad were true breeds for autosomal dominant and autosomal recessive alleles, respectively. Ellie is bad at both singing and dancing. What is the probability that their first child will be good at singing and bad at dancing? Suppose that the ROSE and LISA genes are located 42.4 centimorgans apart. What is the probability that their first child will be bad at singing and dancing?

   (a) 50%; 28.8%

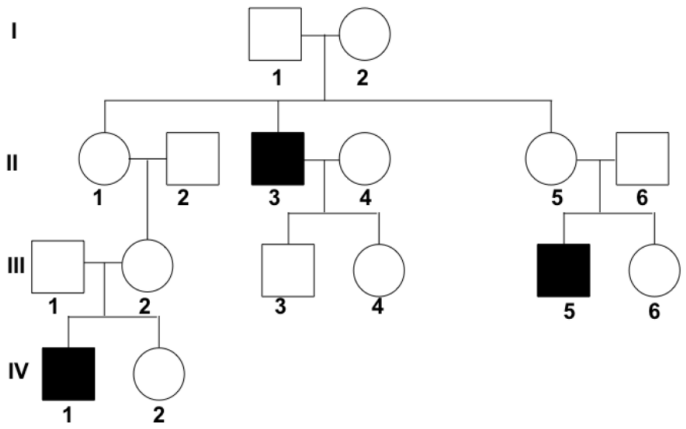
   (b) 50%; 42.4%

   (c) 25%; 28.8%

   (d) 25%; 42.4%

   (e) 0%; 0%

7. The pedigree shown below indicates affected individuals with a black color. The trait is most likely inherited in which of the following manners?



   (a) Autosomal Dominant

   (b) Autosomal Recessive

   (c) X-linked Dominant

   (d) X-linked Recessive

   (e) Codominance

8. From the pedigree, which of the following individuals definitely does not have an allele for the trait?

   (a) Generation 1, individual 2

   (b) Generation 2, individual 4

   (c) Generation 3, individual 3

   (d) Generation 4, individual 1

   (e) None of the above

9. RNPs are ribonucleic particles consisting of RNA binding proteins (RBPs) and the RNA. RBPs regulate so much of RNA functions like splicing and modifications. This can go the other way around as well where RNAs regulate RBPs, termed riboregulation. Which of the following is false?

   (a) Riboswitches, mRNA elements that bind metabolites or metal ions as ligands and regulate mRNA expression through transport out of the cell in response to this ligand binding.

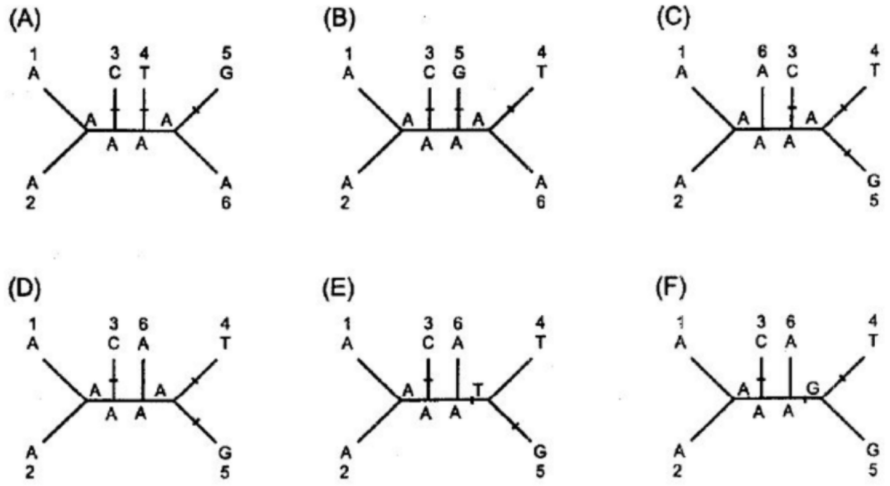
   (b) K-homology is a RNA binding domain.

   (c) RBPs can bind hundreds of RNA targets, but only subsets may be regulated under particular cellular conditions.

   (d) Mutations in genes encoding RBPs can alter their expression levels.

   (e) Protein kinase R (PKR), the binding of which to double-stranded RNA induces protein dimerization and autophosphorylation, results in activation of the enzyme.

10. When looking for maximum parsimony trees, nucleotide or amino acids sites that have the same nucleotide for all taxa are eliminated from the analysis. Only variable sites are used. Which of the following is false?



(a) Tree A has 3 substitutions.

(b) Tree B has 3 substitutions.

(c) In tree D, you can assign substitutions to both interior and exterior branches.

(d) Any nucleotide site at which only unique nucleotide sites exist is not informative because nucleotide variation at the site can always be explained by the same number of substitutions in all topologies.

(e) All variable sites can be used.

Answer Key

C1. B

C2. A

C3. B

C4. D

C5. C

C6. E

C7. C

C8. D

C9. A

C10. C

A1. A

A2. E

A3. E

A4. A

A5. A

A6. B

A7. D

A8. E

A9. C

A10. D

P1. C

P2. E

P3. E

P4. E

P5. E

P6. D

P7. A

P8. E

P9. C

P10. E

G1. B

G2. C

G3. B

G4. C

G5. C

G6. C

G7. D

G8. C

G9. A

G10. E