The 61st Annual
Merck State Science Day Competition
May 17, 2011

BIOLOGY

Directions:

PLEASE DO NOT OPEN THE EXAM BOOKLET UNTIL DIRECTED.

Be sure to fill in your name on the answer sheet both by printing it in the correct space, and by filling in the corresponding letter in the provided spaces.

Use a #2 pencil only.

Carefully erase any errors, and do not make any extraneous marks on the answer sheet. Do NOT use *White-Out* on any portion of the answer sheet.

The test has **120 items** that will be scored. You have **90** minutes in which to answer all the questions.

There is only one correct answer per question. Do not spend too much time on any one question. Do the items you find easier first, and then go back to those you find more difficult or time consuming during the time you have remaining. Your individual score will be computed on the basis of the number of correctly answered items. (There is no penalty for guessing.)

Merck State Science Day 2011 BIOLOGY

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question and place your selection ON THE ANSWER SHEET.

1. Why can a hypothesis never be 'proven' true in science?
- **A)** Science is limited by the use of human senses.
- **B)** One can never collect enough data to be 100% positive.
- **C)** Experimental error is involved in every research project.
- **D)** Science evolves; hypotheses and therefore theories are always changing.
- **E)** There may always be alternative untested hypotheses that might account for the results with different or new technologies.

2. The principal point of Darwin's theory of evolution by natural selection is that;
- **A)** most mutations have favorable effects.
- **B)** mutations are caused by varying environmental factors.
- **C)** long term heritable changes in organisms are caused by use and disuse.
- **D)** survival of characteristics in a population depends on competition between organisms, especially between members of the same species.
- **E)** mutations that adapt an organism to a given environment always arise in the greatest frequency in the organisms that occupy that environment.

3. Clay particles in clay soil contain layered aluminum and iron compounds that determine the pattern of adjacent layers. This technically is a 'self-replicating molecular assemblage' which is one of the characteristic to define life.
- **A)** Therefore clay is living.
- **B)** Clay is not living because it does not require energy.
- **C)** Clay is not living because there is no chemical changes involved in soil.
- **D)** Clay is not living because this does not involve carbon; if carbon is present, then this would be a living system.
- **E)** Clay is not living because this formation is a simple repetitive process without the ability to evolve or respond to the environment.

4. Monosaccarhides are characterized by all *except* which if the following?
- **A)** carbon, hydrogen, and oxygen in a 1:2:1 ratio.
- **B)** the presence of an amine and carboxyl group.
- **C)** a molecule of three to seven carbon atoms.
- **D)** multiple hydroxyl groups.
- **E)** a carbonyl group.

5. Which of the following disciplines is mismatched with its description?
- **A)** genomics - studying whole sets of genes of a species and between species.
- **B)** technology - inventing practical uses and applications of scientific knowledge.
- **C)** model organisms - using type organisms to characterize each domain and kingdom.
- **D)** taxonomy - identifying and naming organisms, and placing them in hierarchical categories.
- **E)** scientific inquiry - generating hypotheses; formulating predictions; conducting experiments or making observations.

6. In the past century, the average temperature of the oceans has increased by 0.74^0C. Is this evidence of global warming (climate change)?

A) Yes, because of the high specific heat of water and the huge volume of water in the oceans, a small rise in temperature would reflect a large amount of heat absorbed by the oceans.
B) increase.No, the change of average temperature does not reflect the quantity of heat in the oceans.
C) Yes, the decreased rate of calcification is directly related to this temperature
D) No, global warming affects air temperature, not water temperature.
E) No, the rise in temperature is too small to be significant.

7. What is a key difference between a local regulator and a hormone?

A) Local regulators are small, hydrophobic molecules; hormones are either larger polypeptides or steroids.
B) Local regulators initiate short-term responses; hormones trigger longer-lasting responses to environmental stimuli.
C) Local regulators diffuse to neighboring cells; hormones usually travel throughout the plant or animal to distant target cells.
D) Local regulators often open ligand-gated channels and affect ion concentrations in a cell; hormones bind with intracellular receptors and affect gene expression.
E) The signal transduction pathways of local regulators do not involve secondary messengers; pathways triggered by hormones do involve secondary messengers.

8. The endosymbiotic hypothesis states that prokaryotes became some of the organelles of early eukaryotic cells. This would be supported by what evidence?

A) Mitochondria and chloroplast are nearly identical to some free living prokaryotes.
B) The endoplasmic transport system is similar in both prokaryotes and eukaryotes.
C) The mitochondria and chloroplast have their own DNA and ribosomes
D) Both A and C are correct, but not B.
E) A, B, and C are correct.

9. Which of the following statements about the cell is *not* true?

A) The plasma membrane is described as a fluid mosaic model.
B) In a plasma membrane, proteins shift positions and phospholipids flex their tails.
C) The glycoproteins have their sugar side chains on the outside of the cell membrane.
D) The cell membrane is symmetrical, so it is impossible to identify which is the extracellular surface.
E) The intracellular matrix of the plasma membrane is used as a scaffolding for many of the integral and peripheral proteins.

10. In the ABC model of flower development in *Arabidopsis thaliana*, fused carpels form when which of the following gene(s) is (are) switched on?

A) A only
B) C only
C) A and B
D) A and C
E) B and C

11. Which of these events occurs first in seed germination?

A) imbibition of water.
B) release of gibberellins.
C) transcription of the amylase gene.
D) activation of protein-digestive enzymes in the endosperm.
E) digestion of the endosperm starch into transportable sugars.

12. Which of the following are *not* paired correctly?
A) bone - osteoblasts embedded in a mineral matrix.
B) adipose tissue - loose connective tissue with fat-storing cells.
C) loose connective tissue - collagenous, elastic, and reticular fibers.
D) fibrous connective tissue - chondrocytes embedded in chondroitin sulfate.
E) blood -- connective tissue consisting of erythrocytes, leukocytes, and platelets in plasma.

13. Which of the following statements is the *best* explanation for the presence of four-chambered hearts in both birds and mammals?
A) They share a common ancestor that had a four-chambered heart.
B) They are the only vertebrates with double circulation, which requires four heart chambers.
C) The more inefficient single atrium of amphibians and most reptiles could not supply the higher O_2 needs of these endotherms.
D) They are both endotherms, and the evolution of efficient circulatory systems supported the high metabolic rate of endotherms.
E) This is an example of convergent evolution, because animals that obtain their O_2 from air require both a pulmonary circuit and a systemic circuit.

14. Which of the following is the correct sequence of the steps involved in the helper T cell activation of cell-mediated and humoral immunity?

1. Macrophage and helper T cell secrete cytokines.
2. Macrophage engulfs pathogen and presents antigen in class II MHC.
3. Plasma cells secrete antibodies, and cytotoxic T cells attack cells with class I MHC molecule-antigen complex.
4. T cell receptor recognizes class II MHC molecule-antigen complex.
5. Activated B cells form plasma cells and memory cells, and activated T cells form cytotoxic T cells and memory cells.

A) 2, 1, 4, 5, 3
B) 2, 4, 1, 5, 3
C) 5, 1, 2, 4, 3
D) 5, 2, 4, 1, 3
E) 1, 3, 5, 2, 4

15. Which of the following statements is *not* true?
A) Sapwood surrounds heartwood.
B) Apical meristems are in both the root and shoot systems.
C) Some perennial plants may consist of primary growth only.
D) Cork cambium and vascular cambium are cells that form lateral growth.
E) Phloem is formed on the inside of the vascular cambium, whereas xylem is formed on the outside.

16. Which of the following is the correct sequence in the change in plant species from lower to higher elevations along eh western slope of the Sierra Nevada?
A) hardy dwarf --> deciduous --> coniferous --> grass
B) deciduous --> grass --> coniferous --> hardy dwarf
C) grass --> deciduous --> coniferous --> hardy dwarf
D) deciduous --> coniferous --> grass --> hardy dwarf
E) hardy dwarf --> grass --> deciduous --> coniferous

17. Subsistence agriculture does *not* utilize
A) natural fertilizers
B) variety of crops
C) human labor
D) native crops
E) GMOs

18. Eutrophication is associated with all of the following characteristics of a lake *except;*
A) increased abundance of anaerobic decomposers
B) abundant oxygen at all levels
C) abundant phytoplankton
D) limited transparency
E) decrease in depth

19. A study of a cohort of 1,000 animals showed a 90% death rate per individual in the first year, 10% the second year and 5% the third year. This population's survivorship is
A) type I
B) type II
C) type III
D) type I the first year and type II in years two and three
E) type I the first year and type II the second year, and type III the third year

20. The work of Reznick and Endler with guppies shows all of the following *except* that;
A) life history evolve.
B) life history traits can be inherited.
C) life history traits are coded for in DNA.
D) life history traits can be altered over a short period of time.
E) predation does not influence the modification of life history traits.

21. Crick and Brenner discovered that the presence of three extra nucleotides inserted in the middle of a gene caused far fewer problems than if only one or two extra nucleotides were inserted. They interpreted this result to mean that
A) the genetic code consists of nonoverlapping triplets of nucleotide bases.
B) the wobble effect accounts for the unpredictability in codon-anticodon pairing at the third base.
C) there is specificity in the genetic code, in that each triplet codon only codes for one specific amino acid.
D) there is redundancy in the genetic code, in that more than one triple codon may code for the same amino acid.
E) the longer the sequence of nucleotides that is added to a gene, the more chemically stable the resulting DNA is.

22. Which example best illustrates the principle of commensalism?
A) Cattle egrets feed on insects accidentally disturbed by grazing cattle.
B) Harmless Viceroy butterflies resemble distasteful Monarch butterflies.
C) Ants that feed on Acacia tree secretions defend the tree against attackers.
D) The population of mussels on intertidal rocks is kept in check by sea stars that feed on them.
E) Tiny fishes called Wrasse pick parasites off other species of fish at 'cleaning stations' on the coral reef.

23. Which ecosystem most likely possesses the highest primary productivity per acre?
A) Alpine meadow.
B) Temperate, coniferous rainforest.
C) Beech/maple hardwood climax forest.
D) Mesotrophic, tropical, freshwater lake.
E) Subtropical, estuarine mangrove swamp.

24. Which of the following genotypes would produce the greatest variety of gametes if the alleles assorted independently?
A) aa BB Cc Dd
B) Aa Bb CC Dd
C) aa bb CC DD
D) AA BB CC Dd
E) AA bb cc Dd

25. It is believed that the atmosphere of the primitive Earth was composed largely of carbon dioxide, nitrogen, and water vapor. The composition of certain iron-containing minerals suggests that the carbon dioxide began to be replaced by oxygen about 2.6 billion years ago. Which of the following is the *best* explanation for the change in atmospheric composition?

A) Cyanobacteria evolved and relied on the process of photosynthesis, and not chemosynthesis, that now released oxygen.
B) Ozone produced in the upper atmosphere by ultraviolet light break down to release atmospheric oxygen.
C) Minerals such as iron oxide spontaneously released oxygen into the atmosphere.
D) Water was split into atmospheric oxygen and hydrogen by lightning discharges.
E) Oxygen was released in volcanic gases and slowly accumulated over time.

26. If the egg of a megagametophyte of a flowering plant has a marker gene designated by A and the sperm cell of a compatible pollen grain has a marker gene designated as B, which of the following represents the endosperm that will result from fertilization in the majority of flowering plants?

A) AA
B) BB
C) AB
D) AAB
E) ABB

27. You are a director of research for a drug company. Which of the following would most likely be worth developing as a cancer chemotherapy treatment?

A) a drug that prevents tetrad formation.
B) a drug that interferes with cellular respiration.
C) a drug that prevents sister chromatids from separating at anaphase.
D) none of the above would be worth the expense to research and develop.
E) a drug that causes cells to divide at a right angle from their usual orientation.

28. A lateral root forms on the primary root of a typical herbaceous dicot by

A) lateral outgrowth of xylem.
B) lateral outgrowth from the root apical meristem.
C) continued growth of a root hair on an epidermal cell.
D) activation of a lateral bud at a node on the surface of the root.
E) activation of an area in the pericycle to form an apical meristem.

29. In organisms with closed circulatory systems, fluid leaves the blood of capillary networks at the arterial end and returns to blood at the venous end for which of the following reasons?

A) Hydrostatic pressure drops during diastole.
B) Osmotic pressure increases prior to dehydration.
C) Hydrostatic pressure difference dominates at both the arterial and the venous ends.
D) Osmotic pressure difference dominates at the arterial end; hydrostatic pressure difference dominates at the venous end.
E) Hydrostatic pressure difference dominates at the arterial end; osmotic pressure difference dominates at the venous end.

30. The ability of a desert rodent's kidneys to form highly concentrated urine is largely due to ;

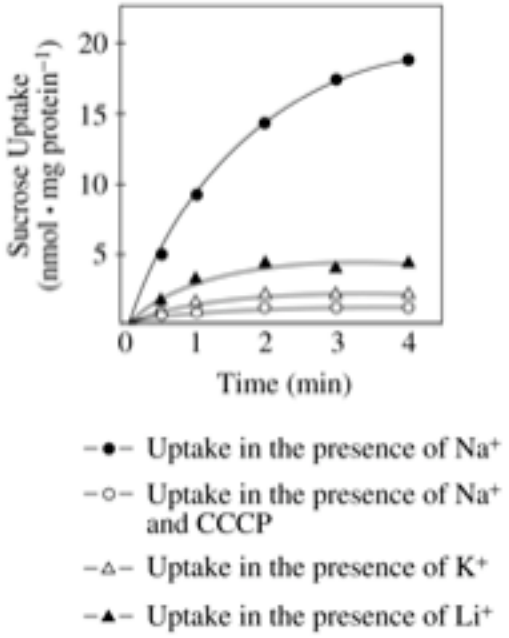
A) a high glomerular filtration rate
B) distal convoluted tubules that are impermeable to water
C) the production of a concentrated salt ultrafiltrate in the glomerulus
D) the ability of cells lining the proximal convoluted tubule to absorb water
E) long loops of Henle that pass through tissues of increasing salt concentrations

31. Which of the following mineral nutrients is directly involved in light absorption during photosynthesis?

A) Mg^{2+}
B) Ca^{2+}
C) Cu^{2+}
D) Mn^{2+}
E) Zn^{2+}

32. Some chemoautotrophic bacteria that live near deep-sea vents obtain their energy by converting
A) carbon dioxide and hydrogen to methane
B) hydrogen sulfide to elemental sulfur
C) alcohols to aldehydes
D) nitrogen to ammonia
E) iron oxides to iron

Use the graph below for the following three (3) questions.
The graph below contains data obtained in an experiment designed to determine the mechanism of sucrose uptake by the marine bacterium *Vibrio alginolyticus*. Sucrose uptake was determined by incubating washed cells in [^{14}C] sucrose for short periods of time, harvesting, rewashing the cells, and measuring the sucrose present. Uptake was measured in the presence of Na^+, Na^+ plus CCCP (an inhibitor of proton gradient formation), K^+, and Li^+.

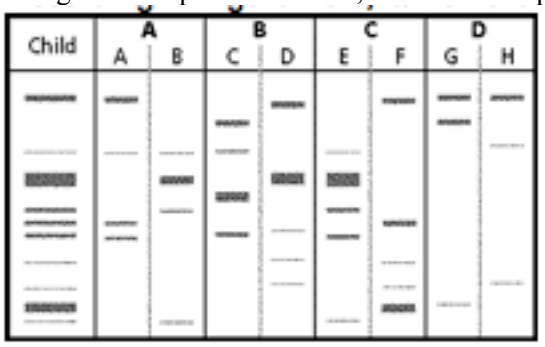


33. Based on the data, which of the following statements best describes the uptake of sucrose by these cells?
A) Sucrose transport is not dependent on Na^+
B) Sucrose transport occurs by only one mechanism.
C) Sucrose crosses the membrane by simple diffusion.
D) Sucrose is transported by a carrier-mediated system.
E) Sucrose is not transported into the cell under most conditions.

34. The primary reason for testing the effects of CCCP is to determine whether
A) Na^+ transport occurs alone.
B) none of the above are reasons.
C) the effect of Li^+ is dependent on Na^+
D) K^+ can substitute for Na^+ in sucrose transport.
E) a proton gradient is required for sucrose transport.

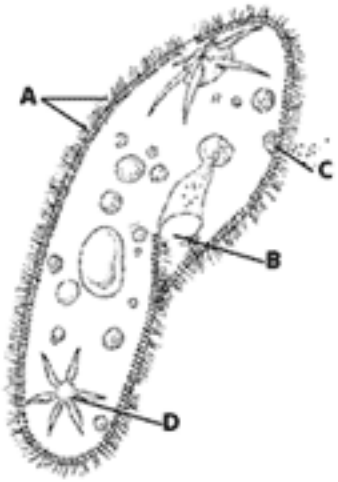
35. Which of the following is the *best* explanation for the effects of Li^+ and K^+ on the uptake of sucrose?
A) These ions bind to sucrose and block its entry into the cell.
B) These ions are allosteric effectors of the sucrose transporter system.
C) These ions decrease the net Na^+ available in the cells for cotransport.
D) These ions are not transported rapidly by the Na^+/sucrose cotransporter system.
E) These ions uncouple the respiratory process that generates energy for the uptake of sucrose

36. According to the results of the gel electrophoresis below, which are the parents of the child?



A) couple A
B) couple B
C) couple C
D) couple D
E) couple B or C could potentially be the parents: additional tests are needed to determine

37. The organism below is placed in which eukaryotic Clade and which structure is the primary derived characteristic used for this classification?

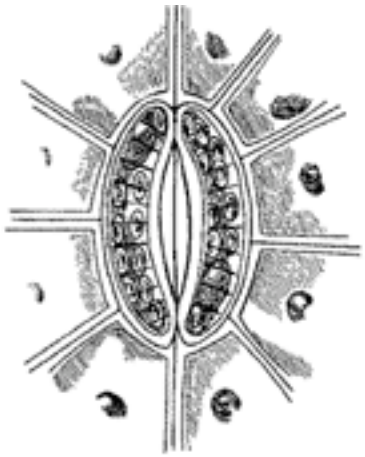


A) Chromalveolates -- D
B) Excavates -- A
C) Chromalveolates - A
D) Rhizaria - A
E) Unikonts - B

38. Ca^{2+} is important in skeletal muscle contraction because it
A) activates the myosin ATPase by binding to it.
B) is required to detach the myosin head from the actin filament.
C) binds to troponin to remove a constant inhibition of cross-bridge attachment.
D) causes muscle relaxation at intracellular concentrations of Ca^{2+} higher than 10^{-6}M.
E) prevents the formation of bonds between the myosin cross bridges and the actin filament .

39. As a research biologists, a colleague brings an animal to you for classification. The animal has a coelom, jointed appendages, and metameric segmentation. Your best classification would be to place this animal in the Phylum
A) Cnidaria
B) Mollusca
C) Chordata
D) Arthropoda
E) Platyhelminthes

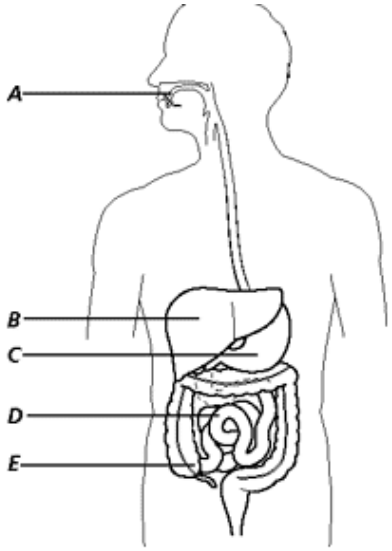
40. What explanation is the best to use for the structure shown below?



A) the rate of gases will continue to facilitate normal rates of photosynthesis, while water is being conserved with the decreased transpiration rate
B) the plant is under minimal water stress and there is a normal rate of transpiration occurring
C) there is a larger concentration of K^+ inside the guard cells than outside the guard cells
D) the rate of photorespiration in a C-3 plant would increase in the conditions shown
E) this demonstrates the stomatal closure during the night in the CAM plants

41. A piece of prospective belly epidermis of a newt neural-stage embryo is grafted to the prospective mouth region of a frog neurula, replacing the frog epidermal tissue at that spot. The grafted embryo continues to develop and forms a newt mouth and teeth at the position of the graft. This result is consistent with which of the following?
A) Newt tissue dedifferentiates whenever it is grafted.
B) The mouths and teeth of frogs and newts are the same in type of tissue.
C) The frog tissues of the neurula induce the newt tissue to form mouthparts.
D) Newt tissue develops autonomously according to its fate map, despite its new location in the frog embryo.
E) Tissues of the frog neurula induce the newt tissue to express frog-specific genes that it would not normally express.

42. Which of the labeled structures would be the site of the release of amylase?



A) A only
B) C only
C) D only
D) A and C
E) A, B, and C

43. Dikaryotic hyphae are a kind of fungal tissue that
A) contain two chromosomes
B) are not found in the ascomycota
C) are formed by the fusion of two nuclei
D) form after plasmogamy and before karyogamy
E) are only a short stage of the life cycle of the Basidiomycota

44. Most of the dry mass of a plant is derived from
A) carbon from the soil.
B) nitrogen from the soil.
C) minerals from the soil.
D) carbon from the atmosphere.
E) oxygen from the atmosphere.

45. Which of the following describes members of both the Bryophyta and Pteridophyta?
A) The absence of true roots.
B) The presence of chlorophyll.
C) The absence of swimming sperm.
D) The absence of meristematic growth.
E) The dominance of the gametophytic generation of the life cycle.

46. Which of the following animal phyla is diploblastic?
A) Rotifera
B) Cnidaria
C) Mollusca
D) Nematoda
E) Platyhelminthes

47. A unicellular eukaryote that contains chlorophyll *a* (lacks chlorophyll *b*), that functions as one of the major photosynthetic autotrophs in open-ocean ecosystems and that has cell walls composed of silica is a
A) diatom
B) red alga
C) euglenoid
D) green alga
E) dinoflagellate

48. The Calvin cycle cannot occur at night in a living plant. Which of the following best describes why this is true?
A) Several enzymes necessary for the Calvin cycle activity are degraded during the day and must have light to be replaced
B) The reactions of the Calvin cycle are dependent on light reactions for high-energy compounds
C) Cooler temperatures at night slow enzyme activity and rates of substrate diffusion
D) The stomata are not able to open at night, thus CO_2 cannot enter the leaf
E) Light is required to transport water necessary for the cycle

49. Which of the following is the tissue that is most important in plant survival during droughts and why?
A) Vascular tissue - the phloem keeps the plant supplied with water.
B) Vascular tissue - the xylem can store considerable amounts of water.
C) Ground tissue - water can be stored in the sclerenchyma for use during droughts.
D) Ground tissue - the parenchymal tissue provides hormonal cues to stop water loss.
E) Dermal tissue - covered with a waxy cuticle and includes drought-responsive stomata.

50. Which of the following is *not* true regarding the cell's metabolic pool?
A) Carbohydrate intake can result in the formation of fat.
B) Metabolites of the Krebs cycle can be converted to amino acids.
C) Carbohydrates represent the most efficient form of stored energy.
D) Fatty acids are converted to acetyl-CoA, which enters the Krebs cycle.
E) Plants are able to synthesize all of the amino acids they need, but animals cannot.

51. In the fetal heart, the lungs are deflated and the fetus receives oxygen from its mother across the placenta through the umbilical cord. If the foramen ovale does not grow closed prior to birth, which of the following symptoms would be expected?

A) Deoxygenated blood would mix with oxygenated blood and the systemic circulation would have too little oxygen to sustain healthy growth.
B) This would not actually cause any harmful effects since the heart would compensate by a slight increase in the respiration rate.
C) This would result in a heart murmur because there would be no 'back pressure' to close the atrio-ventricular valves .
D) It would cause hypertension - fetal blood pressure would be abnormally high.
E) This would balance the diastolic and systolic blood pressure readings.

52. The order in which light reaches the lens of a human eye is

A) lens --> aqueous humor --> pupil --> lens
B) pupil --> cornea --> aqueous humor --> lens
C) cornea --> pupil --> aqueous humor --> lens
D) cornea --> aqueous humor --> pupil --> lens
E) cornea --> vitreous humor --> pupil --> lens

53. Which of these descriptions could be associated with the luteal phase of the uterine cycle?

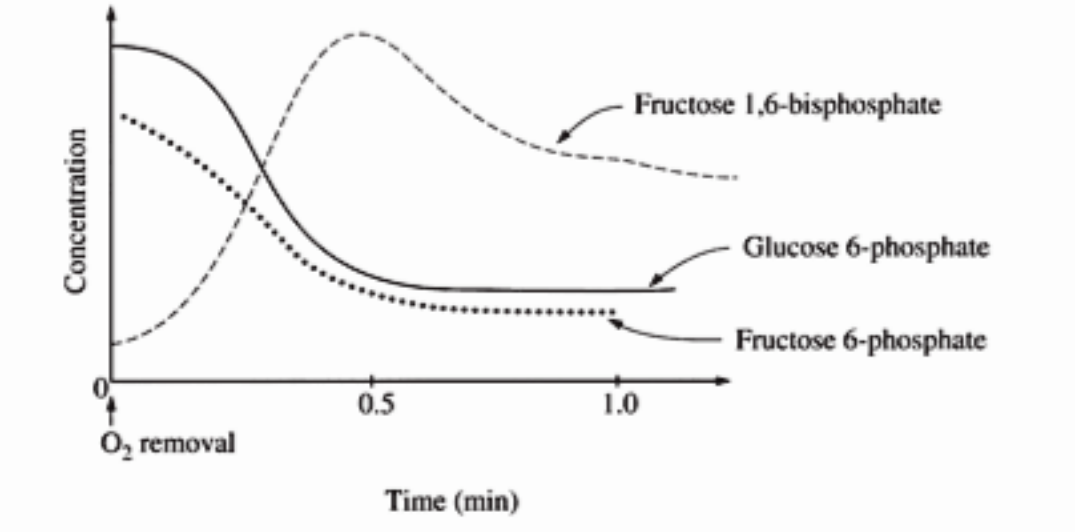
A) decrease in LH, increase in progesterone, corpus luteum present, secretory uterine lining.
B) decrease in LH, decrease in progesterone, corpus luteum present, secretory uterine lining .
C) increase in LH, increase in progesterone, corpus luteum present, endometrium released
D) low FSH, high estrogen, developing follicle, increase in endometrium.
E) high LH, high estrogen, developing follicle, endometrium breakdown.

54. An incompletely dominant gene controls the color of chickens so that *BB* produces black, *Bb* produces a slate-gray color (blue), and *bb* produces splashed white. A second gene controls comb shape, with the dominant gene *R* producing a rose comb and *r* producing a single comb. If a pure-breeding, black chicken with a rose comb is mated to a splashed, white chicken with a single comb -- in the F_2 generation, what fraction of the offspring will be blue with rose comb?

A) 9/16 **C)** 3/16 **E)** 1/16
B) 3/8 **D)** 1/8

For questions 55 - 57: Use the following information:

Muscle cells were incubated in the presence of O_2 and then quickly made anoxic. The concentrations of various metabolites were measured immediately following the removal of O_2. The results are shown in the figure below.



55. The change in the glucose 6-phosphate concentration can best be explained by;
- **A)** increased rate of glycolysis.
- **B)** increased synthesis of glycogen.
- **C)** increased conversion to free glucose.
- **D)** decreased synthesis of glucose 6-phosphate.
- **E)** acceleration of the citric acid (Krebs) cycle.

56. The initial increase in the concentration of fructose 1,6-bisphosphate is most likely due to;
- **A)** inhibition of aldolase.
- **B)** activation of gluconogenesis.
- **C)** activation of phosphofructokinase.
- **D)** increase in the concentration of ATP.
- **E)** increase in the concentration of citrate (citric acid).

57. Which of the following is most likely to happen to the concentration of lactate in the cell?
- **A)** It will remain the same.
- **B)** It will increase to a new steady-state level.
- **C)** It will decrease because the cell secretes the lactate.
- **D)** It will decrease because the cell uses lactate to synthesize glucose.
- **E)** It will increase initially and then decrease to control values as equilibrium is reached.

58. Common lesions found in DNA after exposure to ultraviolet light are known as
- **A)** single strand breaks
- **B)** pyrimidine dimers
- **C)** transpositions
- **D)** purine dimers
- **E)** base deletions

59. Which of the following is the most likely mechanism for the origin of multigene families?
- **A)** convergent evolution of dissimilar genes
- **B)** horizontal gene transfer
- **C)** gene duplication
- **D)** endosymbiosis
- **E)** viral infection

60. Most biomass pyramids show a rapid decrease in biomass as trophic levels increases. In aquatic systems, however, this pattern may be reversed so that it can be observed that the consumers are larger than the autotrophs. What explains this pattern?

A) Biomass in aquatic systems cannot be measured accurately.
B) Zooplankton reproduce quickly, but have poor survival success.
C) Phytoplankton is rapidly consumed, but have a high turnover rate.
D) Aquatic producers tend to have larger body sizes than terrestrial producers.
E) Water is an easier medium to live in and aquatic organisms require less food.

61. If the intracellular release of calcium within a fertilized egg cell were blocked or inhibited, what effect would this have on reproduction?

A) The sperm and egg nuclei will not fuse.
B) The acrosomal reaction would be blocked.
C) The fast block to polyspermy would not occur.
D) The fertilization envelope would not be formed.
E) The zygote will not be able to complete normal mitotic divisions.

62. Three different bird species live in sympatry. Each species specializes in feeding on a different size of seed. This would be an example of

A) competitive exclusion principle.
B) interference competition.
C) resource partitioning.
D) sympatric symmetry.
E) symbiosis.

63. Competitive inhibitors of enzymes can be reversed by

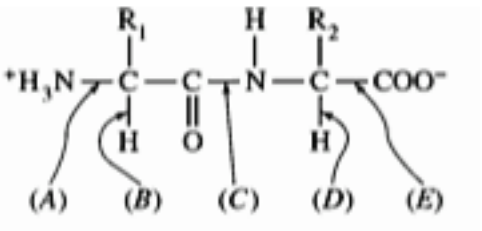
A) lowering the temperature below the enzyme's optimal range
B) increasing the pH above the enzyme's optimal range
C) increasing the concentration of substrate
D) adding noncompetitive inhibitors
E) removing the cofactors

64. Reasons that the population of an exotic species often grows more rapidly when it is introduced to the new environment include

I. The exotic species is resistant to pesticides
II. There is a large, underutilized food source in the new environment
III. The exotic species has few natural predators in the new environment

A) I only
B) II only
C) I and III
D) II and III
E) I, II, and III

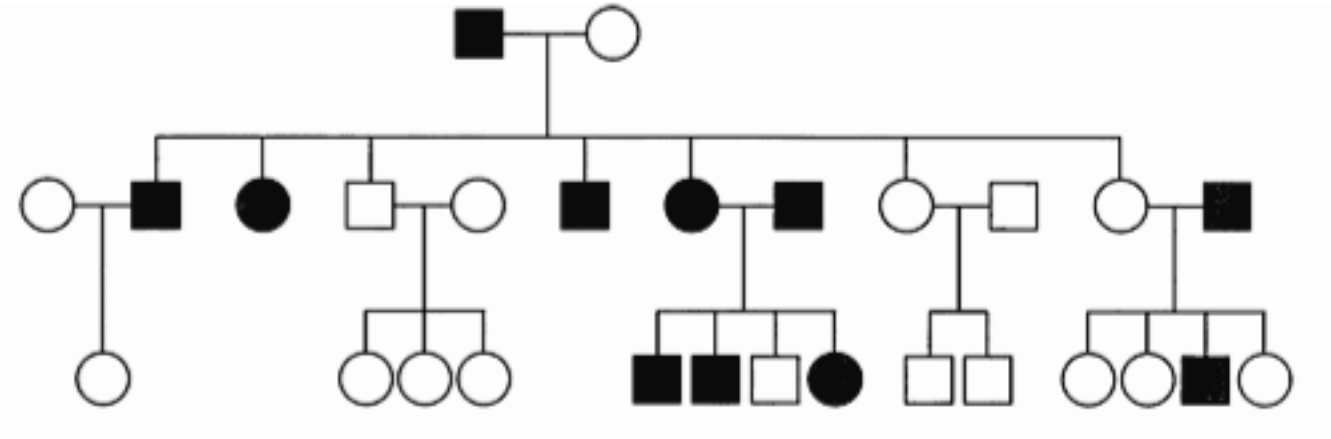
65. A peptidase hydrolyzes peptide bonds in small proteins. In the dipeptide shown below, which bond would be hydrolyzed?



A) A **B)** B **C)** C **D)** D **E)** E

66. All of the following cellular events involve actin filaments *except*
A) cytokinesis
B) amoeboid movement
C) cytoplasmic streaming
D) contraction in smooth muscles
E) flagellar movement in bacteria

67. In the pedigree below, which of the following is the most probable mode of inheritance of this trait?



Circles = females Squares = males Shaded = expression of trait studied
A) polygenic inheritance
B) simple Mendelian dominant
C) simple Mendelian recessive
D) x-linked dominant transmission
E) codominant relationship of a single pair of alleles

68. Which of the following is a density-independent factor that could limit a population of high-altitude butterflies?
A) scarcity of oviposition sites
B) competition for nectar
C) late spring snowstorm
D) parasitism
E) predation

69. A biome with dry and rainy seasons, ground cover of tropical grasses, and trees scattered is a
A) taiga **D)** savanna
B) prairie **E)** chaparral
C) tundra

70. Catabolic repression in *E.coli* bacteria, involving the CAP (catabolite activator protein), is a type of positive regulation. Which of the following is the best explanation for this?
A) Glucose binds to CAP and activates transcription .
B) Glucose binds to CAP and inactivates RNA polymerase.
C) cAMP-CAP enhances RNA polymerase activity for transcription.
D) cAMP-CAP prevents RNA polymerase from initiating transcription.
E) lactose binds to the active repressor that binds to the CAP and initiates transcription.

71. Proteins associated with DNA in a eukaryotic chromosome have all of the following functions *except*
A) regulation of DNA replication.
B) regulation of gene transcription.
C) attachment to the plasma membrane.
D) stabilization of chromosome structure.
E) catalysis of deoxynucleoside triphosphate polymerization.

72. Which of the following is *not* associated with the lytic cycle of a bacteriophage?
A) production of a prophage.
B) possible generalized transduction .
C) cutting up of the bacterial chromosome.
D) assemblage of the nucleic acid and protein coat.
E) none: all are associated with the lytic cycle.

73. The metabolic rates of endotherm and ectotherm animals differ based on the environment. In late summer, the oxygen consumption of a tree squirrel and of a salamander were first measured after 1 hour at 20^0C and then after 1 hour at 10^0C. Which of the following best describes their respective oxygen consumption as the temperature changed from 20^0C to 10^0C?

	Tree Squirrel	**Salamander**
A)	increased	remained constant
B)	decreased	remained constant
C)	decreased	increased
D)	increased	increased
E)	increased	decreased

74. Which of the following adaptation appeared for the first time in the common ancestor of the mammals, birds, and modern reptiles that had a dramatic evolutionary advance?
A) membranous lungs
B) internal nostrils
C) tetrapod limbs
D) amniotic eggs
E) hinged jaws

75. In the phloem of many plants, companion cells provide metabolic energy for movement of solutes into and out of the sieve-tube elements. Which is the best explanation for this?
A) There are no plasmodesmata between companion cells and sieve-tube members.
B) There is an abundance of mitochondria in the companion cells.
C) There is an abundance of rRNA in the sieve-tube members.
D) There are high rates of translocation at low temperatures .
E) There are low rates of respiration in companion cells.

76. Under aerobic conditions, many blue-green alga (cyanobacteria) reduce atmospheric nitrogen in
A) capsules
B) exospores
C) homocysts
D) endospores
E) heterocysts

77. Crossing over is one of the most important events in meiosis because it
A) it produces new combinations of alleles on chromosomes.
B) homologous chromosomes must be separated into different .
C) homologous chromatids must be separated into different daughter cells.
D) the number of chromosomes distributed to each daughter cell must be halved.
E) all of these are attributed to the process of cross-over.

78. Which of the following is a postzygotic isolating mechanism in speciation?
A) selective forces act throughout the species' lifetime
B) speciation rates are not related to evolutionary rates
C) speciation and morphological divergence are weakly associated
D) morphological changes occur through selection on polygenic variants
E) major morphological changes are separated by long periods of morphological changes.

79. Island biogeography is said to be 'biological hotspots' and the 'showcase for evolution'. Which two processes contribute to these features?
A) allopatry and adaptive radiation
B) sympatry and adaptive radiation
C) parapatry and adaptive radiation
D) allopatry and convergent evolution
E) sympatry and convergent evolution

80. Risks of genetic engineering include all of the following except
A) accidental transformation of non-target organisms
B) increase in antibiotic resistance bacteria
C) GMOs escaping into the environment
D) inadvertently transfer allergens
E) none; all of the following are risks of genetic engineering

81. People that carry a mutation in the serotonin transporter are known to be susceptible to
A) depression
B) schizophrenia
C) cystic fibrosis
D) multiple sclerosis
E) muscular dystrophy

82. The tertiary structure and function of a polypeptide is primarily due to the
A) interactions between amino acid present in the polypeptide
B) repeated units of glycogen making up the polypeptide
C) number of nucleotides present in the polypeptide
D) number of introns within the polypeptide
E) length of the polypeptide

83. During the winter, squirrels experience a sustained period of cold weather. The squirrel's thyroid gland responds by secreting a greater amount of thyroxine. Which of the following represents the correct pathway from the CNS to the target cells?

A) CNS --> thyroid --> thyroxin --> target cells
B) CNS --> posterior pituitary --> thyroid --> target cell
C) CNS --> adrenal medulla --> thyroid --> thyroxin --> target cells
D) CNS --> motor neurons --> muscle cells --> thyroxin --> target cells
E) CNS --> hypothalamus --> anterior pituitary --> thyroid --> target cells

84. Which of the following causes the rapid change of membrane polarity during an action potential?
A) Diffusion of positively charged ions across the cell membrane.
B) Active transport of cations by the sodium-potassium pump.
C) Diffusion of neurotransmitters such as acetylcholine.
D) Release of electrons from inside the cell.
E) Release of protons from inside the cell.

85. A large assemblage of cichlids (fish) is subdivided by the water level lowering and isolating them into separate pools. This divides them into two populations (A and B) for an indefinitely long period. From an evolutionary standpoint, which of the following is *least* likely to occur in the two populations?
A) Under laboratory conditions, cross fertilization between members of the two species may be successful even after a long period of geographical separation.
B) Population A may undergo polyploidy and now have double the chromosomes to make them larger, which is a survival advantage in the 'new' environment.
C) Population A may ultimately develop a different behavior to attract a mate.
D) Populations A and B may eventually differ in their ecological requirements.
E) The two populations may become morphologically very dissimilar.

86. How are antibodies and complement related?
- **A)** Antibodies bind to antigens on a pathogen's membrane may activate compliment proteins to form a membrane attack complex.
- **B)** Complement proteins tag foreign cells for destruction; antibodies destroy cells by opsonization.
- **C)** They are both coded for by genes that have hundreds of alleles.
- **D)** They are both involved in innate defenses.
- **E)** They are both produced by plasma cells.

87. Which of the following animals is *incorrectly* paired with the description of its nervous system?
- **A)** annelid worm - brain, ventral nerve cord with segmental ganglia
- **B)** hydra (cnidarian) - ring of ganglia leading to multiple nerve cords
- **C)** squid (mollusc) - large complex brain, ventral nerve cord, some giant axons
- **D)** sea star (echinoderm) - modified nerve net, central nerve ring with radial nerves
- **E)** vertebrate - central nervous system of brain and spinal cord, and peripheral nervous system

88. Which of the following statements regarding the senses of gustation and olfaction is *not* true?
- **A)** There is no distinction between these senses in aquatic animals.
- **B)** There are as many as 1000 more genes for olfactory receptors that for gustation receptors.
- **C)** Olfactory sensory cells are neurons; gustotory receptor cells are modified epithelial cells that synapse with sensory neurons.
- **D)** Each taste cell has a single type of receptor; each olfactory cell can have receptors that respond to several olfactory molecules.
- **E)** Taste receptors of insects are located in sensory hair on the feet and mouthparts; olfactory hairs are located on the antennae.

89. The finding of harmful levels of DDT in the bald eagles is known as
- **A)** biological magnification
- **B)** phytoremediation
- **C)** biological control
- **D)** eutrophication
- **E)** none of the above

90. Ecosystem services include all of the following *except*
- **A)** pollination of crops
- **B)** decomposition of wastes
- **C)** purification of air and water
- **D)** production of antibiotics and drugs
- **E)** reduced impact of weather extremes

91. Which of the following characteristics is typical of biodiversity hot spots?
- **A)** low species diversity
- **B)** a high rate of habitat degradation
- **C)** a large number of endemic species
- **D)** large populations of migratory birds
- **E)** a large region of land or aquatic area

92. Clear-cutting tropical forests yields agricultural land with limited productivity because
- **A)** few of the ecosystem's nutrients are stored in the soil; most are in the forest trees.
- **B)** the tropical forest regrows rapidly and will out compete agricultural crops .
- **C)** decomposition rates are high but primary production is low in the tropics.
- **D)** phosphorus, not nitrogen, is the limiting nutrient in those soils.
- **E)** it is too hot in the tropics for most food crops.

93. When the starfish were removed from a tidal pool of Tatoosh Island, Paine found that the pool's species diversity was significantly reduced. The starfish was most likely

A) an index species
B) a strong parasite
C) a keystone species
D) a strong competitor
E) a resource partitioner

94. Which of the following descriptions is an example of a fixed-action pattern?

A) a blackcap (bird) migrating to its winter territory.
B) a digger wasp returning to its nest with the use of landmarks.
C) a male stickleback chasing a red-belled object from its territory.
D) a songbird learning its song after listening to a tape of its species' song.
E) a crane in a captive-breeding program imprinting on its human caregiver.

95. In a frog embryo, gastrulation

A) occurs along the primitive streak.
B) is slowed by the large amount of yolk.
C) involves the formation of the notochord and neural tube.
D) produces a blastocoel this is displaced into the animal hemisphere.
E) proceeds by involution as cells roll over the dorsal lip of the blastopore.

96. The RAAS and ADH both increase water reabsorption, but they respond to different osmoregulatory problems. Which two of the following statements are true?

1. ADH will be released in response to high alcohol consumption
2. ADH is released when osmoregulatory cells in the hypothalamus detect an increase in blood osmolarity
3. The RAAS will increase the osmolarity of urine due to the cooperative actions of renin, angiotensin II, and aldosterone
4. The RAAS is a response to a rise in blood pressure or volume
5. The RAAS is most likely to respond following an accident or a severe case of diarrhea

A) 1 and 4
B) 1 and 5
C) 2 and 3
D) 2 and 4
E) 2 and 5

97. Which of the following would be *least* likely to be true of an animal that is a regulator?

A) It may have a larger geographic range than a conformer.
B) Much of its energy budget can be allocated to reproduction.
C) It may acclimatize to winter by increasing the thickness of its insulating coat.
D) It can live in a variable climate because of its dynamic equilibrium mechanisms.
E) It has behavioral as well as physiological mechanisms for responding to changing conditions.

98. Which of the following events may result from the clear-cutting of tropical forests?

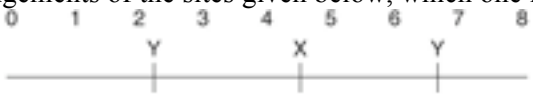
A) a loss of potential medicines.
B) an increase in atmospheric CO_2 levels.
C) extinctions of many plant and animal species.
D) a rise in temperature and a decrease in rainfall in the area.
E) all of the above may result from clear-cutting.

99. A linear piece of viral DNA of 8 kb can be cut with either of two restriction enzymes (X and Y). These are subjected to electrophoresis and produce the following bands:

X	Y
—	
	—
—	
	—

Cutting the same 8 kb piece with both enzymes together results in bands at 4.0, 2.5, 1.0, and 0.5. Of the possible arrangements of the sites given below, which one is most likely?

A)

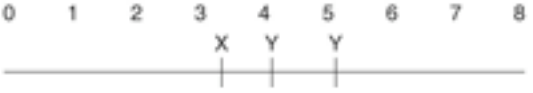


B)

C)

D)

E)



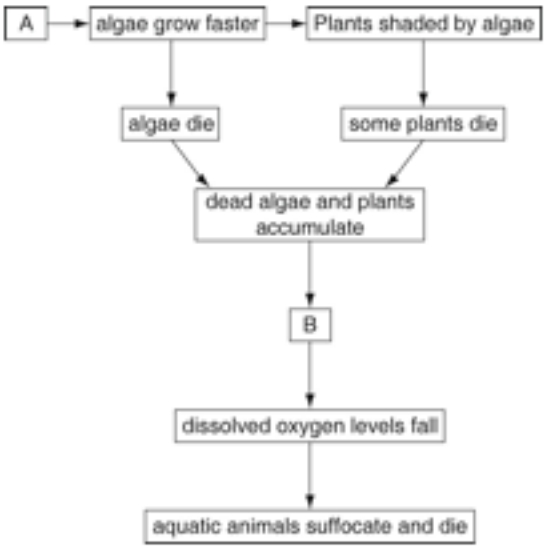
100. Which of the following approaches would allow a biologist studying the evolution of five similar species of lizards to choose the best phylogenetic tree from all possible phylogenies?

A) Draw the simplest tree and choose that one.
B) Determine which species can interbreed; those that can interbreed evolved from a common ancestor most recently.
C) Compare the entire genomes of each species; the two most similar genomes are the two species that are most closely related.
D) From a comparison of DNA sequence, determine the number of evolutionary events required for each tree and then choose the most parsimonious tree.
E) Choose the tree that has the most evolutionary changes, as this would be the most likely explanation for how these very similar lizards evolved into five distinct species.

101. The discovery that a complex human has roughly the same number of genes as the simple nematode *C. elegans*, can best be explained by which of the following statements?

A) Human genes code for many more types of domains.
B) The human genome has a high proportion of noncoding DNA
C) More than one polypeptide can be produced from a human gene by alternative splicing.
D) The large number of SNPs in the human genome provides a great deal of genetic variability.
E) The unusually long introns in human genes are involved in regulation of gene expression

Use the diagram below that illustrates several steps involved in eutrophication to answer questions 102 and 103.



102. What would be a likely entry for Box A?
A) increased sunlight.
B) .increased temperature.
C) elimination of zooplankton
D) increased ultraviolet radiation.
E) fertilizers washed into the lake.

103. What would be a likely entry for Box B?
A) plants no longer producing oxygen.
B) fish that cannot acclimate to low oxygen levels.
C) warm water holding less water than cold water.
D) carbon dioxide building up from cellular respiration by decomposers.
E) decomposer population carries on cellular respiration and uses up oxygen.

104. Assuming that fertilization occurs within a gymnosperm megasporangium, which of the following is the correct sequence of development?
1. sporophyte embryo
2. female gametophyte
3. egg cell
4. megaspore

A) 4 --> 3 --> 2 --> 1
B) 4 --> 1 --> 2 --> 3
C) 4 --> 2 --> 3 --> 1
D) 1 --> 4 --> 3 --> 2
E) 1 --> 4 --> 2 --> 3

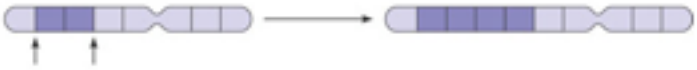
105. A cell whose cytoplasm has a concentration of 0.02 molar glucose is placed in a test tube of water containing 0.04 molar glucose. Assuming that glucose is not actively transported into the cell, which of the following describes the tonicity of the external solution relative to the cytoplasm of the cell?
A) turgid
B) flaccid
C) isotonic
D) hypotonic
E) hypertonic

106. Which of the following chromosomal aberrations would potentially cause the least problems in the individual?

A)

B)

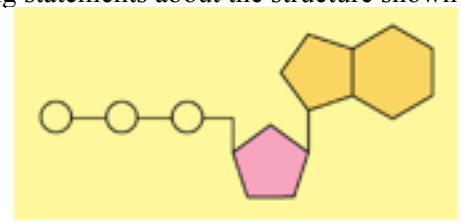
C)



D)

E) Both a and b would not necessarily cause problems in an individual

107. Which of the following statements about the structure shown below is *not* correct?



A) Is usually necessary for the function of kinases.
B) Is necessary for the process of facilitated diffusion.
C) Belongs to the macromolecule group of the nucleic acids.
D) When this molecule is hydrolyzed, the energy is used for endergonic reactions in the cell.
E) This molecule may be formed by the process of substrate-level phosphorylation in plants, bacteria, and some animal cells.

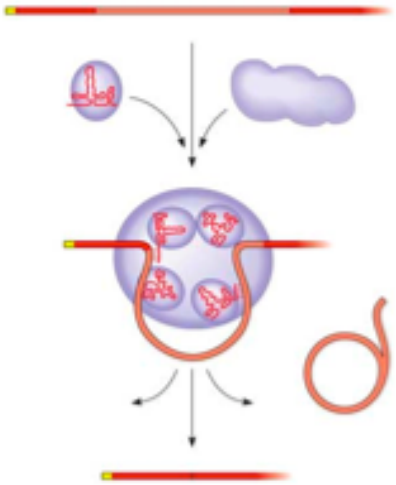
108. The product of the bicoid gene in *Drosophila* is most closely considered a(n)
A) inductive signal
B) positional factor
C) maternal effect
D) egg-polarity gene
E) cytoplasmic determinant

109. Which type of metabolic poison would *most directly* interfere with glycolysis?
A) an agent that reacts with oxygen and depletes its availability in the cell.
B) an agent that closely mimics the structure of glucose but cannot be metabolized.
C) an agent that binds to the cytochrome III complex in the electron transport chain.
D) an agent that reacts with OAA and does not allow it to accept the acetyl group to form citrate.
E) an agent that makes the electron transport membrane 'leaky' so the proton gradient is not generated.

110. Whereas the bacteria divide by binary fission, the majority of eukaryotes divide by mitosis; the diatoms and dinoflagellates have what are termed intermediate mitotic organization. In what sense are these protists intermediate?

A) They still use binary fission in their early stages of development and then by mitosis when they are mature.
B) They never coil up their chromosomes when they are dividing.
C) They use mitotic division but only have circular chromosomes.
D) They do not form spindles during the process of mitosis.
E) They maintain a nuclear envelope during cell division.

For questions 111 - 112 use the diagram that is shown below.



111. Which of the following is *not* descriptive of the process shown above?

A) The beginning molecule is called the pre-mRNA.
B) The end product is called the mRNA that will be transported out the nuclear pores.
C) Within the spliceosome, snRNA base pairs with nucleotides at specific sites along the intron.
D) The mRNA will then be 5'-capped and a poly-A tail at the 3' end (left to right respectively).
E) The snRNPs and other proteins combine to form the spliceosome that will splice out the exons and process the introns for transport.

112. Which of the following statements is *not* correct regarding the process shown?

A) This is a universal process that occurs in all three domains of life.
B) RNA splicing can occur without proteins or even additional RNA molecules.
C) Ribozymes may be involved in this process that rendered the idea that all biological catalysts are proteins obsolete.
D) This process may be considered of evolutionary importance, as now the same region of the 'gene' may produce a variety of polypeptide products.
E) This process may be considered of evolutionary importance, as now there may be 'leftover' coding sections of past ancestors and / or 'fuel' for new beneficial variants of the gene.

113. Which statement about the geological time scale is *not* correct?

A) Reptiles originated during the Paleozoic era
B) Mammals originated early in the Mesozoic era
C) Eukaryotes originated during the Proterozoic eon
D) Mass extinction of the dinosaurs occurred approximately 65 million years ago
E) Adaptive radiation of flowering plants, insects, and birds took place during the Mesozoic era

114. The study of comparative embryology reveals the conservative nature of the genes responsible for
A) size
B) intelligence
C) food procurement
D) reproductive behavior
E) embryonic development

115. Of 400 people who dwell on a Pacific island, 16 are homozygous recessive for a trait that has only two different types of alleles in the population. The number of heterozygotes expected is
A) 256
B) 168
C) 128
D) 64
E) Not enough information is given

116. The Hubbard Brook watershed studies revealed the importance of tree roots in preventing loss of calcium from an ecosystem. Calculation of calcium loss is performed by sampling
A) lakes in the watershed
B) the soil of the watershed
C) water exiting the watershed
D) water in streams in the watershed
E) the roots of the trees in the watershed

117. Which of the following scientists is *least* related to the others based on their contributions to the study of biology?
A) Griffith
B) Morgan
C) Chargaff
D) Hershey-Chase
E) Messelson-Stahl

118. The drug cytochalasin B blocks the function of actin. Which of the following activity of the animal cell cycle would be most disrupted by the exposure to cytochalasin B?
A) formation of kinetochore spindle fibers
B) centriole production of spindle fibers
C) DNA semi-conservative replication
D) cell elongation during anaphase
E) cytokinesis following telophase

119. Which of the following is considered an ancestral trait and *not* a derived trait of land plants?
A) sporopollenin
B) apical meristems
C) multicellular gametangia
D) multicellular gametangia
E) alternation of generations

120. Which of the following is an example of positive feedback regulation?
A) The hormones insulin and glucagon regulate blood-sugar levels.
B) A rise in body temperature when you exercise stimulates sweating and increased blood flow to the skin.
C) When cells have sufficient energy available, the activity of phosphofructokinase is inhibited to an extent.
D) Increasing global temperatures cause more ice melts / glacier calving, and this then absorbs more radiation, which increases the average temperature at the poles faster than the equatorial regions.
E) All of the above are examples of positive feedback regulation.

END

Merck State Science Day 2011 **BIOLOGY**
Answer Section

MULTIPLE CHOICE

1.	E	41.	C	81.	A
2.	D	42.	A	82.	A
3.	E	43.	D	83.	E
4.	B	44.	D	84.	A
5.	C	45.	B	85.	B
6.	A	46.	B	86.	A
7.	C	47.	A	87.	B
8.	D	48.	B	88.	D
9.	D	49.	E	89.	A
10.	B	50.	E	90.	D
11.	A	51.	A	91.	C
12.	D	52.	D	92.	A
13.	D	53.	A	93.	C
14.	B	54.	B	94.	C
15.	E	55.	A	95.	E
16.	C	56.	C	96.	E
17.	E	57.	B	97.	B
18.	B	58.	B	98.	E
19.	C	59.	C	99.	B
20.	E	60.	C	100.	D
21.	A	61.	D	101.	C
22.	A	62.	C	102.	E
23.	E	63.	C	103.	A
24.	B	64.	D	104.	C
25.	A	65.	C	105.	E
26.	D	66.	E	106.	E
27.	C	67.	B	107.	B
28.	E	68.	C	108.	C
29.	E	69.	D	109.	B
30.	E	70.	C	110.	E
31.	A	71.	C	111.	E
32.	B	72.	A	112.	A
33.	D	73.	E	113.	E
34.	E	74.	D	114.	E
35.	D	75.	B	115.	C
36.	C	76.	E	116.	C
37.	C	77.	A	117.	B
38.	C	78.	E	118.	E
39.	D	79.	A	119.	A
40.	D	80.	E	120.	D