Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

1. List the order of the following compounds as you first encounter them during the process of cellular respiration.
   1. glyceraldehyde-3-phosphate
   2. pyruvate
   3. glucose
   4. acetyl CoA
   5. fructose bisphosphate
   6. CO₂
   A) 5, 3, 1, 2, 6, 4
   B) 3, 5, 1, 2, 6, 4
   C) 3, 5, 2, 1, 4, 6
   D) 6, 4, 1, 2, 3, 5
   E) 5, 3, 2, 1, 6, 4

2. The metabolic function of fermentation is to
   A) make alcohol
   B) oxidize pyruvate in order to release more energy
   C) produce lactate during aerobic exercise
   D) oxidize NADH to NAD⁺ so that glycolysis can continue in the absence of oxygen
   E) reduce NADH so that more ATP can be produced by the electron transport chain

3. What might introns have to do with the evolution of new proteins?
   A) The excised introns are transcribed and translated as new proteins by themselves
   B) Introns are more likely to accumulate mutations than exons, and these mutations then result in the production of novel proteins
   C) Introns that are self-excising may also function as hydrolytic enzymes for other processes
   D) Introns provide more area where crossing over may occur (without interfering with the coding sequences) and thus increase the probability of exon shuffling between alleles
   E) Introns often correspond to domains in proteins that fold independently and have specific functions. Changing domains between nonallelic genes could produce novel proteins
4. The restriction fragment contains a gene whose recessive allele is lethal. The normal allele has restriction sites for the restriction enzyme PSTI at sites I and II. The recessive allele lacks restriction site I. An individual who had a sister with the lethal trait is being tested to determine if he is a carrier of that allele. Indicate which of these band patterns would be produced on a gel if he is a carrier (heterozygous) for the gene.

A) a  B) b  C) c  D) d  E) e

5. A mutation that produces a nonfunctional product of a regulatory gene for an inducible operon would result in
A) continuous transcription of the genes of the operon
B) complete blocking of the attachment of RNA polymerase to the promoter
C) irreversible binding of the repressor to the operator
D) no difference in transcription rate when an activator protein was present
E) negative control of transcription

6. How does DNA synthesis along the lagging strand differ from that on the leading strand?
A) Nucleotides are added to the 5’ end instead of the 3’ end
B) Ligase is the enzyme that polymerizes DNA on the lagging strand
C) An RNA primer is needed on the lagging strand but not on the leading strand
D) Okazaki fragments, which each grow 5’ --> 3’ must be joined along the lagging strand
E) Helicase synthesizes Okazaki fragments, which are then joined by ligase

7. One difference between the electron transport system in photosynthesis and respiration is that in photosynthesis
A) NADPH rather than NADH passes electrons to the electron transport chain
B) ATP synthase releases ATP into the stroma rather than into the cytosol
C) Light provides the energy to push electrons to the top of the electron chain, rather than energy from the oxidation of food molecules
D) an H+ concentration gradient rather than a proton-motive force drives the phosphorylation of ATP
E) both a and c are correct

8. Which of the following is a key difference between seedless vascular plants and vascular seed plants?
A) The gametophyte generation is dominant in the seedless plants, whereas the sporophyte is dominant in the seed plants
B) The spore is the agent of dispersal in the first, whereas the seed functions in dispersal of the second
C) Seedless plants are heterosporous; seed plants are homosporous
D) The embryo is unprotected in the seedless plants but retained within the female reproductive structure in the seed plants
E) Sporopollenin is not found in the seedless plants

9. Archaea
   A) are believed to more closely related to eukaryotes than to bacteria
   B) have cell walls that lack peptidoglycan
   C) are often found in harsh environments, reminiscent of the hostile conditions of early Earth
   D) include the methanogens, extreme halophiles, and extreme thermoacidophiles
   E) are all of the above

10. A plasmid has two antibiotic resistance genes, one for ampicillin and one for tetracycline. It is treated with a restriction enzyme that cuts in the middle of the ampicillin gene. DNA fragments containing a human globin gene were cut with the same enzyme. The plasmids and fragments are mixed, treated with ligase, and used to transform bacterial cells. Clones that have taken up the recombinant DNA are the ones that
   A) are blue and can grow on plates with both antibiotics
   B) can grow on plates with ampicillin but not with tetracycline
   C) can grow on plates with tetracycline but not with ampicillin
   D) cannot grow in the presence of either of the antibiotics
   E) can grown on plates with tetracycline and are blue

11. If the gene encoding the lac repressor is mutated so that it can no longer bind to the operator, will transcription of that operon occur?
   A) Yes, but only when lactose is present
   B) No, because RNA polymerase is necessary to transcribe the genes
   C) Yes, because the operator will not be bound by the repressor and RNA polymerase can transcribe the lac operon
   D) No, because cAMP levels are low when the repressor is nonfunctional
   E) Yes, but only when glucose levels are low

12. All of the following statements concerning gene expression in eukaryotes are true EXCEPT?
   A) Chromosome puffs are sites of active mRNA synthesis
   B) The mRNA synthesized in the nucleus is modified before it goes to the ribosome where translation takes place
   C) The euchromatic regions of a chromosome contain active genes while the heterochromatic regions contain inactive genes
   D) Gene expression in the nucleus is controlled by histone proteins
   E) Promoter regions function as regulatory sites that influence the binding of RNA polymerase

13. A certain type of grass has a diploid chromosome number of 8. A similar species of grass has a diploid chromosome number of 10. Interspecific hybridization between the two species results in sterile hybrids that can reproduce vegetatively. The chromosome number of those hybrids would be
   A) 9  B) 14  C) 18  D) 20  E) 36

14. As a research scientist, you measure the amount of ATP and NADPH consumed by the Calvin cycle in 1 hour. You find 35,000 molecules of ATP consumed, but only 22,000 molecules of NADPH. Where did the extra ATP molecules come from?
   A) photosystem II
   B) photosystem I
   C) cyclic photophosphorylation
   D) noncyclic photophosphorylation
   E) produced in the Calvin-Benson cycle
15. The allele for pea comb (P) in chickens is dominant to the allele for single comb (p), but the alleles for black (B) and white (B') feather color show codominance. BB' individuals have “blue” feathers. If birds heterozygous for both pairs of genes are mated, what proportion of the offspring are expected to be white feathered and pea-combed?
   A) 9/16  D) 8/16
   B) 3/16  E) 2/16
   C) 1/16

16. The C-4 pathway in plants:
   A) takes place in the bundle sheath cells
   B) produces PGA
   C) replaces the C-3 pathway
   D) produces oxaloacetate, then malate
   E) occurs in the Crassulaceae family of plants

17. Which of the following would NOT be expected in an individual that is taking a diet pill that contains DNP?
   A) Their metabolic rate would increase
   B) Their body temperature would increase
   C) Their production of ATP would increase
   D) Their blood glucose levels would most likely drop quickly and they may resort to proteins to drive respiration
   E) The cristae in the mitochondria become ‘leaky’ and allow the H⁺ through thus not utilizing the proton-motive

18. Which of the following can be diagnosed by examining a karyotype of an individual’s white blood cells?
   A) Alzheimer’s disease
   B) Cystic fibrosis
   C) Sickle cell anemia
   D) Down’s syndrome
   E) Huntington’s disorder

19. Which of the following compounds are generated in the light-dependent reaction that are necessary to drive the light-independent reaction (Calvin-Benson cycle) of photosynthesis?
   A) ATP and CO₂
   B) H₂O and CO₂
   C) ATP and NADPH
   D) ADP and NADP⁺
   E) NADH and FADH₂

20. If an internal probe is used to measure the pH of the mesophyll cells in a particular plant, and the following results are obtained, which classification would you place this plant?
<table>
<thead>
<tr>
<th>Time</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00 AM</td>
<td>4.0</td>
</tr>
<tr>
<td>12:00 noon</td>
<td>6.0</td>
</tr>
<tr>
<td>6:00 PM</td>
<td>7.4</td>
</tr>
<tr>
<td>12:00 midnight</td>
<td>5.3</td>
</tr>
</tbody>
</table>
   This is most likely a:
   A) C-3 plant
   B) C-4 plant
   C) CAM plant
   D) C-3 or a CAM plant
   E) C-4 or a CAM plant

21. During cellular respiration, electrons travel downhill from:
   A) food --> Krebs cycle --> ATP --> NAD⁺
   B) food --> NADH --> electron transport system --> oxygen
   C) glucose --> ATP --> oxygen
   D) glucose --> ATP --> electron transport chain --> NADH
   E) food --> glycolysis --> Krebs cycle --> NADH --> ATP
22. Measurements of the amount of DNA per nucleus were taken on a large number of cells from a growing plant. The measured DNA levels ranged from 4 to 8 picograms per nucleus. One nucleus had 6 picograms of DNA. What stage of the cell cycle was this nucleus in?
A) $G_0$  D) $G_2$
B) $G_1$  E) $M$
C) $S$

23. Which of the two phases in meiosis are the most important in providing the diversity among the gametes?
A) prophase I and prophase II  D) metaphase I and metaphase II
B) prophase I and metaphase I  E) telophase I and telophase II
C) prophase II and metaphase II

24. In a given organism, how do cells at the completion of mitosis compare with cells that are just about to begin mitosis?
A) They have half the amount of cytoplasm and the same number of chromosomes
B) They have the same amount of cytoplasm and half the number of chromosomes
C) They have half the amount of cytoplasm and half the number of chromosomes
D) They have the same amount of cytoplasm and twice the number of chromosomes
E) They have one-fourth the amount of cytoplasm and half the number of chromosomes

25. In plants, the cells in which the greatest quantity of organic nutrients are translocated are
A) companion cells  D) vessel elements
B) tracheids  E) lenticels
C) sieve-tube elements

26. In a certain flock of sheep, 4 percent of the population has black wool and 96 percent has white wool. Assume that the population is in Hardy-Weinberg equilibrium. If the black wool is a recessive trait, what percent of the population is heterozygous for this trait?
A) 4%  D) 64%
B) 32%  E) 92%
C) 48%

27. Which of the following characteristics is common to all vascular plants that exhibit an alternation of generations in their life cycle?
A) Large, independent gametophytes
B) Multicellular sporophytes
C) Fertilization in water
D) Diploid spores
E) Seed production

28. Gibberellic acid stimulates the cells of germinating grass seeds to produce mRNA molecules that code for hydrolytic enzymes. In this case the role of gibberellic acid can best be described as that of
A) a regulator of gene activity
B) a stimulator of hydrolase secretion
C) a stimulator of DNA replication
D) an allosteric activator of hydrolase
E) an activator of translation

29. The rate of flow of water through the xylem is regulated by
A) passive transport by the pith
B) the force of transpiration pull
C) the number of companion cells in the phloem
D) active transport by the sieve tube members
E) active transport by tracheid and vessel cells
30. Which statement about plant structure is true?
   A) Sclerenchyma cells provide support for the plant body
   B) Collenchyma cells form the outer cell layer of the plant
   C) Wood is formed from old epidermal cells
   D) Stomates are pores in the roots that allow nutrients to enter
   E) Parenchyma cells have thicker cell walls than other plant cells

31. Which of the following is part of the egg-producing structure in plants?
   A) The microgametophyte in gymnosperms
   B) The sori of ferns
   C) The anthridium of mosses
   D) The megaspore mother cell in angiosperms
   E) The megagametophyte of angiosperms

32. Once a plasmid has incorporated specific genes, such as the gene coding for the antibiotic ampicillin, into its genome, the plasmid may be cloned by;
   A) inserting it into a virus to generate multiple copies
   B) treating it with a restriction enzyme in order to cut the molecule into fragments
   C) inserting it into a suitable bacterium in order to produce multiple copies
   D) running it on a gel electrophoresis in order to determine the size of the gene of interest
   E) infecting it with a mutant cell in order to incorporate the gene of interest

33. Which of the following characteristics are of both bacteria and fungi?
   A) cell wall, DNA, and plasma membrane
   B) nucleus, organelles, and unicellularity
   C) plasma membrane, multicellularity, and Golgi apparatus
   D) cell wall, unicellularity, and mitochondria
   E) nucleus, RNA, and cell wall

34. If a photosynthesizing plant began to release \( ^{18}\text{O}_2 \) instead of normal oxygen, one could most reasonably conclude that the plant had been supplied with
   A) CO\(_2\) containing radioactive oxygen
   B) H\(_2\)O containing radioactive oxygen
   C) C\(_6\)H\(_{12}\)O\(_6\) containing radioactive oxygen
   D) NO\(_2\) containing radioactive oxygen
   E) RuBP containing radioactive oxygen

35. Proteins that are to be synthesized and then secreted pass through what series of organelles?
   A) nucleus --> Golgi body --> rough E.R. --> vesicles --> plasma membrane
   B) nucleus --> rough E.R. --> Golgi body --> vesicles --> plasma membrane
   C) nucleus --> rough E.R. --> lysosomes --> plasma membrane
   D) nucleus --> vesicles --> rough E.R. --> Golgi body --> plasma membrane
   E) nucleus --> Golgi body --> vesicles --> rough E.R. --> plasma membrane

36. Carnivorous plants are most likely to be found in which of the following environments?
   A) a tropical savannah
   B) a temperate deciduous forest
   C) an arid desert
   D) a nitrogen-poor swamp
   E) a nutrient-laden tropical rainforest canopy

37. Which of the following has NOT been established as an aspect of auxin’s role in plant cell elongation?
   A) Auxin initiates a loosening of cell wall fibers
   B) Auxin activity permits an increase in turgor pressure
   C) Auxin stimulates proton pumps
D) Auxin increase the quantity of cytoplasm in the cell
E) Through auxin activity, vacuoles increase in size

38. The criteria for a good model organism for studying development would probably include all of the following EXCEPT;
A) preexisting knowledge of the organism’s life history
B) observable embryonic development
C) a relatively small genome
D) a rare pattern of development when compared to most organisms
E) a short generation time

39. One difference between a cancer cell and a normal cell is that
A) the cancer cell is unable to synthesize DNA
B) the cell cycle of the cancer cell is arrested at the S phase
C) cancer cells are always in the M phase of the cell cycle
D) cancer cells cannot repair their telomers and normal cells can
E) cancer cells continue to divide even though the density-dependent inhibition should stop their division

40. Evolutionary biologist theorize that the chytrids diverged and gave rise to the fungi. Which of the following is NOT one of connections between the chytrids and the ‘higher’ fungi groups?
A) molecular similarities between the r-RNA of the two groups
B) both have cell walls made of chitin
C) both produce colonies with hyphae
D) the similarities of the ultrasounds of the flagellated spores of both groups
E) both exhibit extracellular digestion

41. With increased air and soil pollution, the number of fungi populations have markedly decreased. This may be a major concern with the connection that;
A) many wild mushrooms will no longer be available for harvest
B) the major recyclers will disappear and many food chains will collapse
C) many trees and plants will decrease their growth and health due to the symbiotic relationship they have with ‘plant root’ fungus
D) the breakdown of rock to soil, due to their enzymatic reactions, will decrease and therefore the plant life will decrease
E) no concerns: a benefit will result due to the reduced number of spores that cause allergies in many people

42. A mycologist discovers what she deems a new species. The fungus is noted to produce conidia and has a fruiting body that contains eight haploid spores lined up in a row. What group of fungus is this most likely to be a member of:
A) zygomycete
B) ascomycete
C) basidiomycete
D) deuteromycete
E) either b or d could be considered

43. All of the following statements about prokaryotes are correct EXCEPT;
A) The cyanobacteria are referred to as causing the ‘oxygen revolution’ as they were the first to carry out photosynthesis
B) Glycolysis most probably evolved in the prokaryotes to regenerate ATP in anaerobic environments
C) The first prokaryotes were likely photoautotrophs that could utilize the abundant light energy and inorganic minerals of the Earth
D) The Archae are more closely related to the Eukaryo than the Eubacteria are to the Eukaryo
E) None of the above: all are true statements
44. According to the endosymbiotic theory on the origin of eukaryotic cells, the chloroplast most likely originated by:
   A) the infoldings of the plasma membrane
   B) engulfment of a photoautotroph which became mutualistic
   C) engulfment of a chemoautotroph which became mutualistic
   D) engulfment of a chemoheterotroph which became mutualistic
   E) mutations of genes for oxygen-using metabolism

45. The restriction enzymes used in biotechnology:
   A) were originally discovered in viruses that were successful in destroying the host bacterial DNA
   B) were originally discovered in bacteria that were successful in destroying the invading viral nucleic acid
   C) were synthetically engineered by a team of biochemists at Harvard
   D) were originally discovered in plants that were resistant to viral infections
   E) were originally discovered in a plant that was being studied with the tobacco mosaic virus

46. The following DNA sequence shows a ‘gene’ encoding a small peptide. The three ‘stop’ codons are UAA, UAG, and UGA.

\[
5' \text{(ATGAAACGTATACGC)} \text{ACTGGCATGTACTCATTATGTATTTAGTC} 3' \\
3' \text{(TACTTTGCATATGCG)} \text{TGACCGTACATGAGTAATACATAAATCAG} 5'
\]

How many amino acids long with the small protein encoded by this ‘gene’ be?
   A) 3  B) 4  C) 5  D) 6  E) 7

47. Which of the following drawings represents a monocot stem?

   A) I only           D) IV only
   B) II only          E) both I and III
   C) III only

48. If the guard cells and surrounding epidermal cells in a plant are deficient in potassium ions, which of the following would occur:
   A) photosynthesis would increase
   B) roots would increase the rate of water uptake
   C) phloem transport would increase
   D) leaf temperatures would increase
   E) all of the above would occur
49. In cucumbers, warty (W) is dominant over dull (w), and green (G) is dominant over orange (g). A cucumber plant that is homozygous for wart and green color is crossed with a dull, orange colored plant. The F₁ are then crossed to produce an F₂ generation. If a total of 144 offspring are produced, how many are expected to be dull, green cucumbers in the F₂ generation?
A) 9  B) 18  C) 27  D) 81  E) 144

50. Which of the following graphs best describes the relationship between reaction rate as a function of the amount of substrate if the amount of enzyme is limited?

![Graphs](image)

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

51. Which of the following is a common energy flow sequence in aerobic respiration, starting with the energy stored in glucose?
A) glucose --> NADH --> pyruvate --> ATP  
B) glucose --> ATP --> NADH --> electron transport chain  
C) glucose --> NADH --> electron transport chain --> ATP  
D) glucose --> oxygen --> NADH --> water  
E) glucose --> FADH₂ --> NADH --> coenzyme A

52. The enzyme directly responsible for almost all carbon fixation on Earth is;
A) PEP carboxylase  
B) ATP synthase  
C) phosphofructokinase  
D) ligase  
E) Rubisco

53. Which of the following is NOT true of the protists?
A) they are unicellular, colonial, coenocytic, or simple multicellular organisms  
B) their cilia and flagella have a 9 + 2 arrangement of microtubules  
C) they are eukaryotic, and are closely related to the eubacteria
D) some are free-living and some are endosymbionts
E) most are aquatic and live in the ocean or in freshwater ponds

54. Malaria is:
   A) transmitted when people drink water tainted with dinoflagellates
   B) is caused by an apicomplexan that spends part of its life cycle in the Anopheles mosquito and part in humans
   C) is caused by a parasitic zooflagellate, Giardia intestinalis
   D) is a more serious form of amebic dysentery, caused by Entamoeba histolytica
   E) is transmitted by the bite of a female tsetse fly

55. Chlorophyll a, chlorophyll b, and carotenoids are found in
   A) green algae, red algae, and plants
   B) green algae, euglenoids, and plants
   C) brown algae, green algae, and golden algae
   D) brown algae, diatoms, and golden algae
   E) green algae, euglenoids, and diatoms

56. Which statement is not true of the basidiomycetes?
   A) Basidiomycetes include both edible and poisonous species
   B) Mushrooms, bracket fungi and puffballs are examples of this group
   C) They produce a secondary mycelium with \( n + n \) hyphae
   D) Their sexual spores are called basidiospores
   E) They have a diploid thallus that produce zoospores

57. When levels of CO\(_2\) are experimentally increased, C-3 plants generally respond with a greater increase in productivity than C-4 plants. This is most likely because;
   A) C-3 plants are more efficient in their use of CO\(_2\)
   B) C-3 plants are able to obtain the same amount of CO\(_2\) by keeping their stomata open for shorter periods of time
   C) C-4 plants do not use CO\(_2\) as their primary source of carbon
   D) the rate of photosynthesis is limited more by CO\(_2\) in C-3 plants than in C-4 plants
   E) Both B and D are correct

58. Which of the following statements regarding coral reefs is FALSE?
   A) Modern reefs can be as old as 2.5 million years old
   B) Coral reefs capture about half of all the calcium flowing into the ocean every year, fixing it into calcium carbonate rock at very high rates
   C) Coral reefs store large amounts of organic carbon and are very effective ‘sinks’
   D) Coral reefs are among the most biologically diverse ecosystems on the planet
   E) Coral reefs are among the most endangered ecosystems on the planet

59. Imagine that you test samples of coastal water polluted with runoff from farms and find detectable levels of phosphates, but not of nitrogen. In a follow-up experiment, you find that if you enrich some of your samples with nitrogen, algal growth is much greater than in unenriched, control samples. Enriching samples with phosphate does not increase algal growth. From your results, the best conclusion would be;
   A) algae populations in these waters could be reduced by decreasing phosphate runoff
   B) eutrophication of these waters could be reduced by adding nitrogen
   C) algae populations in these waers are kept low by high levels of phosphates
   D) nitrogen is the limiting nutrient in these waters
   E) phosphate is the limiting nutrient in these waters

60. Ecologists conclude that there is a biodiversity crisis because
   A) biophilia causes humans to feel ethically responsible for protecting other species
   B) scientists have discovered and counted most of Earth’s species and can now accurately calculate the current extinction rate
C) the current extinction rate is far higher than the rate at any time in the past 100,000 years
D) many potential life-saving medicines are being lost as species become extinct
E) there are too few biodiversity hot spots

61. What is the single greatest threat to biodiversity?
   A) overexploitation of commercially important species
   B) introduced species that compete with or prey on native species
   C) pollution of Earth’s air, water, and soil
   D) disruption of trophic relationships as more and more prey species become extinct
   E) habitat alteration, fragmentation, and destruction

62. If an overlap develops between the ranges of two closely related species, and if the species occupy the same niche in the zone of overlap, what will probably happen in the zone of overlap?
   A) Both species will coexist, provided the environment in the zone of overlap is different from that in either individual range
   B) The species will partition the zone so that half of it is added to the range of each species and there is no overlap
   C) A new species will arise by hybridization
   D) Both species will coexist, provided the environment in the zone of overlap is similar to that of one of the individual ranges
   E) One species will take over most or all of the zone of overlap

63. Which of the following is an example of Batesian mimicry?
   A) the resemblance of the walking-stick insect (a type of mantis) to the twigs of trees
   B) the resemblance of a harmless fly to a bee
   C) the similar appearance of the western meadowlark to the eastern meadowlark
   D) the resemblance of an African sunbird to a Central American hummingbird that occupies a similar niche
   E) none of the above; all are examples of Mullerian mimicry

64. Which of the following conversions does not represent a step in the nitrogen cycle?
   A) nitrates to atmospheric nitrogen
   B) nitrites to nitrates
   C) ammonium to nitrites
   D) atmospheric nitrogen to ammonium
   E) ammonium to atmospheric nitrogen

65. A Type I survivorship curve is the result of which of the following life-history traits?
   A) Infant mortality is much greater than adult mortality
   B) Parents provide extended care for their young
   C) Large numbers of offspring are produced
   D) Most individuals have short life spans
   E) Death rates are constant over the life span

66. A difference between a morula and a blastula is that the
   A) morula has larger cells
   B) blastula has more cells than the morula
   C) blastula has a hollow center, the morula does not
   D) all of the above are differences between the morula and blastula
   E) only A and B are differences between the morula and blastula

67. Humans are chordates. Which animal group is most closely related to the chordates?
   A) echinoderms
   B) mollusks
   C) cnidarians
   D) annelids
   E) arthropods
68. Thalidomide is a chemical that was prescribed as a sedative in the early 1960s. Many women who took the drug during their first trimester gave birth to children with arm and leg deformities. Which developmental process did this drug affect?
   A) determination of the polarity of the zygote
   B) morphogenesis
   C) early cleavage divisions
   D) organogenesis
   E) differentiation of bone tissue

69. When Gurbon transplanted the nucleus of an intestinal cell from a tadpole into an egg cell whose nucleus had been destroyed, the egg developed into a normal frog. This indicated that;
   A) genes are lost in differentiation
   B) the homeobox genes in a transplanted nucleus underwent mutation
   C) scientists can clone a human being by putting one of his/her nuclei into an egg cell
   D) a nucleus that is removed from its normal location will be influenced by adjoining cells
   E) each cell of an organism has all the genes needed for development

70. An embryo is noted that it is in the developmental event that shows the formation of a primitive gut and has three germ tissue layers. The stage is called;
   A) gastrulation
   B) blastulation
   C) primitive streaking
   D) cleavage
   E) organogenesis

71. Which of the following analogies is incorrect?
   A) limbs -- roots
   B) lungs -- stomata
   C) shelled amniote egg -- fruit
   D) dry, scaly skin -- waxy cuticle

72. How did Darwin’s evolutionary theory change the significance of the taxonomic categories of organisms?
   A) Taxonomists no longer consider anatomical similarity in classifying organisms
   B) Darwin described the Kingdoms that we use today which include all organisms
   C) Darwin’s theory of natural selection has had no effect on taxonomy
   D) Taxonomic categories are now considered to reflect the evolutionary relationships of organisms
   E) The relationships between organisms became completely known and many species were renamed

73. If the weather in Richmond, Virginia, changed to very cold (snow on the ground 8 months of each year) over the next few years, what change might occur?
   A) The cold weather would cause a mutation in squirrels which causes their fur to be white
   B) Evolution would definitely occur resulting in white squirrels
   C) Natural selection would not permit such climatic changes
   D) If a mutation occurred which caused white fur to develop, such white squirrels would have an increased chance to survive and produce more offspring with the characteristic
   E) Natural selection would cause a new genotype to appear in the population, resulting in squirrels with white fur
74. For the next two questions, #74 and 75, refer to the following information.
You are studying three populations of birds. Population 1 has ten birds, of which one is brown (a recessive trait) and nine are red. Population 2 has 100 birds. In that population, ten of the birds are brown. Population 3 has 30 birds, and three of them are brown.
Use the following options to answer the questions.
A. Population 1
B. Population 2
C. Population 3
D. They are all the same
E. It is impossible to tell from the information given

In which population is the frequency of the allele for brown feathers highest?
A) A  B) B  C) C  D) D  E) E

75. Referring to the three populations of birds: Which population is most likely to be subject to the bottleneck effect?
A) A  B) B  C) C  D) D  E) E

76. In a large, sexually reproducing population, the frequency of an allele changes from 0.6 to 0.2. From this change, one can most logically assume that, in this environment,
A) the allele is neutral
B) there is no sexual selection
C) random processes have changed the allelic frequencies
D) the allele mutates readily
E) the allele reduces fitness

77. A lophophore is used by ectoprocts, phoronids, and brachiopods
A) at a larval stage  D) for feeding
B) as a skeletal system  E) for sensory reception
C) for locomotion

78. While sampling marine plankton in a lab, a student encounters large numbers of fertilized eggs. She rears some of the eggs in the laboratory for further study and finds that the blastopore becomes the mouth. The embryo develops into a trochophore larva and eventually has a coelom. These eggs most likely belong to a(n)
A) annelid  D) arthropod
B) echinoderm  E) nematode
C) mollusk

79. In a tide pool, a student encounters an organism with a hard outer covering that contains much calcium carbonate, an open circulatory system, and gills. The organism could potentially be a crab, shrimp, barnacle, or bivalve. Which structure below would allow for the most certain identification?
A) a body cavity  D) a lophophore
B) eyes  E) a heart
C) a mantle
80. What is the correct sequence of the following events, from earliest to most recent, in the evolution of life on Earth?

1. origin of mitochondria
2. origin of multicellular eukaryotes
3. origin of chloroplasts
4. origin of cyanobacteria
5. origin of fungal-plant symbiosis

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

81. In a classic experiment from the 1930s, Tryon conducted selective breeding experiments on maze running behavior in rats. He repeatedly bred maze-bright males (fewest wrong turns before reaching a prize at the end) to maze-bright females and maze-dull males (most mistakes) to maze-dull females. There was a progressive divergence of the two descendent lines resulting in almost no overlap after just eight generations. This study indicates that;

A) maze running is a purely innate behavior in rats
B) maze running is a purely learned behavior
C) trial-and-error learning in rats appears to have a genetic component
D) rats move through a maze randomly
E) nothing can be concluded about maze running behavior in rats from the information provided

82. Male bullfrogs with calls of intermediate loudness (i.e. not the loudest) might have the highest fitness in years;

A) when food is more abundant than normal
B) when females are relatively scarce
C) when males are relatively numerous
D) when predators that locate their prey using sound are very abundant
E) none of the above would be an advantage to affect fitness

83. In a signal transduction;

A) an extracellular signal is converted to an intracellular signal
B) a signal is relayed through a series of molecules in the membrane
C) signal molecules are destroyed before target cells can respond to the signal
D) answers A and B only are correct
E) answers A, B, and C are correct

84. At which level of protein structure are interactions between side chains (R groups) most important?

A) primary
B) secondary
C) tertiary
D) quaternary
E) all of the above are important

85. If a 0.9% NaCl were isotonic to a cell, then

A) 0.9% would also be hypotonic
B) 0.9% would also be hypertonic
C) 1.0% would be hypertonic
D) 1.0% would by hypotonic
E) 0.1% would be hypertonic
86. Concerning the relationship between the cell cycle and cancer:
   A) tumor-suppressor genes produce proteins that combine with cyclin-kinase complex to prevent kinase from becoming active
   B) oncogenes are cancer-causing genes that may code for cyclins that go awry in cancer tissue
   C) cyclin is a protein that activates kinases that activate the cell cycle and it is important in a normal cell cycle to not only create but also destroy cyclin
   D) all of the above are correct
   E) none of the above are correct since the cell cycle is unrelated to the disease of the cancer

87. The following two questions, #87 and #88, are based on the 15 molecules in Figure 5.8. Each molecule may be used once, more than once, or not at all.

![Figure 5.8](image_url)

Which of the following molecules are structural isomers?
   A) 5 and 14
   B) 6 and 12
   C) 12 and 13
   D) 14 and 15
   E) 1 and 4
88. Based on the 15 molecules above, which of the following combinations could be linked together to form a nucleotide?
   A) 1, 2, and 11  
   B) 12, 14, and 15  
   C) 3, 7, and 8  
   D) 11, 12, and 13  
   E) 5, 9, and 10

89. The presence of lacunae, calcium salts, and blood vessels would indicate which type of tissue?
   A) osseous tissue  
   B) areolar tissue  
   C) fibrocartilaginous tissue  
   D) cartilage tissue  
   E) dense connective tissue

90. You are trying to identify a slide that shows a multilayered epithelium with cuboidal basal cells and flattened cells at its surface. This would be classified as;
   A) simple cuboidal  
   B) simple squamous  
   C) stratified squamous  
   D) transitional  
   E) pseudostratified ciliated columnar

91. The inability to absorb digested nutrients and secrete mucus might indicated a disorder in which type of tissue?
   A) simple columnar  
   B) stratified squamous  
   C) simple squamous  
   D) transitional  
   E) stratified columnar

92. If the atrioventricular node could be surgically removed from the heart without disrupting signal transmission to the Purkinje fibers, what would be the effect?
   A) Atria and ventricles would contract at about the same time  
   B) No apparent effect on heart activity would be observed  
   C) Only the ventricles would contract  
   D) The heart rate would be decreased  
   E) Only the atria would contract

93. What would be the long-term effect if the lymphatic vessels associated with a capillary bed were to become blocked?
   A) Fluid would accumulate in interstitial areas  
   B) More fluid would enter the venous capillaries  
   C) Fewer proteins would leak into the interstitial fluid from the blood  
   D) Blood pressure in the capillary bed would increase  
   E) Nothing would happen

94. Why is gas exchange more difficult for aquatic animals with gills that for terrestrial animals with lungs?
   A) Water contains much less O2 than air per unit volume  
   B) Water is denser than air  
   C) Gills have less surface area than lungs  
   D) Only A and B are correct  
   E) A, B, and C are correct

95. If a molecule of CO2 released into the blood in your left toe travels out of your nose, it must pass through all of the following structures except the;
   A) trachea  
   B) right atrium  
   C) pulmonary vein  
   D) alveolus  
   E) right ventricle
96. Blood entering a capillary bed of a vertebrate was measured for the pressures exerted by various factors. The results are given in the following chart:

<table>
<thead>
<tr>
<th></th>
<th>Arterial end of capillary bed</th>
<th>Venous end of capillary bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrostatic pressure</td>
<td>8 mm Hg</td>
<td>14 mm Hg</td>
</tr>
<tr>
<td>Osmotic pressure</td>
<td>26 mm Hg</td>
<td>26 mm Hg</td>
</tr>
<tr>
<td>PO₂</td>
<td>100 mm Hg</td>
<td>32 mm Hg</td>
</tr>
<tr>
<td>PCO₂</td>
<td>40 mm Hg</td>
<td>46 mm Hg</td>
</tr>
</tbody>
</table>

For this capillary bed, which of the following statements is correct?

A) Fluids will leave the capillaries on the arterial side of the bed and re-enter on the venous side.
B) Oxygen is taken up by the erythrocytes within the capillaries.
C) The pH is lower on the arterial side than on the venous side.
D) The hydrostatic pressure declines from the arterial side to the venous side because oxygen is lost.
E) The osmotic pressure remains constant due to carbon dioxide compensation.

97. The factors responsible for holding the lungs to the thorax wall are:

A) the diaphragm and the intercostal muscles.
B) surface tension from pleural fluid, positive pressure, and atmospheric pressure on the thorax.
C) the visceral pleurae and the changing volume of the lungs.
D) the smooth muscles of the lung.
E) surface tension from the visceral pleurae and negative pressure.

98. In order to preserve the taste of low-fat food, companies have started to use synthetic fats that cannot be broken down and absorbed by the digestive system. What problems might be associated with a diet that includes large amounts of these synthetic fats?

A) vitamin C deficiency
B) obesity
C) malnutrition
D) vitamin K deficiency
E) all of the above.

99. A drug that blocks the action of carbonic anhydrase in parietal cells would result in

A) a higher pH during gastric digestion
B) increased protein digestion in the stomach
C) decreased production of pepsinogen by chief cells
D) a lower pH during gastric digestion
E) decreased gastrin production.

100. Mary has a disease that causes a large portion of her gastric mucosa to atrophy. This results in significantly less secretion by the gastric glands. As a result of this condition you would expect Mary to have;

A) diarrhea
B) protein malnutrition
C) obstructive bowel disease
D) dehydration
E) pernicious anemia.

101. Inflammatory responses may include all of the following except;

A) clotting proteins sealing off a localized area
B) increased release of white blood cells from bone marrow
C) reduced permeability of blood vessels to conserve plasma
D) release of histamine to increase the blood supply to an inflamed area
E) increased activity of phagocytes in an inflamed area.
102. The following events occur when a mammalian immune system first encounters a pathogen. Place them in the correct sequence and then choose the answer that indicates this sequence.

I. Pathogen is destroyed
II. Lymphocytes secrete antibodies
III. Antigenic determinants from the pathogen bind to antigen receptors on lymphocytes
IV. Only memory cells remain

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

103. Which of the following would be most beneficial in treating an individual who has been bitten by a poisonous snake that has a fast-acting toxin?

A) injection of interleukin-1
B) injection of interferon
C) injection of interleukin-2
D) injection of antibodies to the toxin
E) vaccination with an attenuated form of the toxin

104. Refer to the following data:

<table>
<thead>
<tr>
<th></th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother</td>
<td>Rh-</td>
<td>Rh-</td>
<td>Rh+</td>
</tr>
<tr>
<td>Fetus</td>
<td>Rh+</td>
<td>Rh-</td>
<td>Rh-</td>
</tr>
</tbody>
</table>

In which of these cases would the precaution likely be taken to give the mother anti-Rh antibodies before delivering her baby?

A) cases 1, 2, and 3
B) case 3 only
C) case 1 only
D) cases 1 and 2 only
E) it cannot be determined from the data given

105. What aspect of the immune response would a patient who has a parasitic worm infection and another patient responding to an allergen such as ragweed pollen have in common?

A) Both patients would suffer from anaphylactic shock
B) Both patients would be suffering from a decreased level of innate immunity
C) Both patients would risk development of an autoimmune disease
D) Both patients would have an increase in cytotoxic T cell number
E) Both patients would have increased levels of IgE

106. The role of acetylcholinesterase is to:

A) destroy ACh a brief period after its release by the axonal terminals
B) amplify or enhance the effect of ACh
C) stimulate the production of serotonin
D) act as a stimulating agent
E) open the Ca$$^{2+}$$ gates of the sarcoplasmic reticulum
107. Given the steps below, which of the following is the correct sequence for transmission at a chemical synapse?
   1. Neurotransmitter binds with receptors associated with the postsynaptic membrane
   2. Ca\textsuperscript{2+} ions rush into the neuron’s cytoplasm
   3. Action potential depolarizes the synaptic terminal membrane
   4. Ligand-gated ion channels open
   5. Synaptic vesicles release neurotransmitter into the synaptic cleft
   A) 4, 3, 1, 2, 5
   B) 1, 2, 3, 4, 5
   C) 3, 2, 5, 1, 4
   D) 5, 1, 2, 4, 3
   E) 2, 3, 5, 4, 1

108. Which process allows materials that are part of the filtrate to be returned to the blood from the distal convoluted tubule?
   A) selective secretion
   B) selective reabsorption
   C) ultrafiltration
   D) pressure filtration
   E) counter-current pressure gradient

109. Which of the following mechanisms for osmoregulation or nitrogen removal is incorrectly paired with its corresponding animal?
   A) Malpighian tubule -- insect
   B) direct cellular exchange -- marine invertebrate
   C) flame bulb -- snake
   D) metanephridium -- earthworm
   E) kidney -- frog

110. The transfer of fluid from the glomerulus to Bowman’s capsule;
   A) usually includes the transfer of red blood cells to the nephron tubule
   B) results from active transport
   C) transfers large molecules as easily as small molecules
   D) is mainly a consequence of blood pressure force-filtering the fluid
   E) is very selective as to which small molecules are filtered

111. Which of the following activities would initiate an osmoregulatory adjustment brought about primarily through the renin-angiotensin-aldosterone system?
   A) eating a pizza with olives and pepperoni
   B) spending several hours mowing the lawn on a hot day
   C) drinking several glasses of water
   D) sleeping
   E) eating a bag of potato chips

112. The ostrich and the emu look very similar and live in similar habitats, however they are not very closely related. This is an example of;
   A) convergent evolution
   B) sympatric speciation
   C) exaptation
   D) adaptive radiation
   E) divergent evolution

113. If organism A, B, and C belong to the same class but to different orders and if organisms D, E, and F belong to the same order but to different families, which of the following pairs of organisms would be expected to show the greatest degree of structural homology?
   A) A and C
   B) B and D
   C) A and B
   D) D and F
   E) C and F
114. White matter (myelinated fibers) is found in all of the following locations, with the exception of the;
   A) corticospinal tracts
   B) corpus callosum
   C) cerebral cortex
   D) outer surface of the spinal cord
   E) peripheral nerves

115. The blood-brain barrier is effective against;
   A) metabolic wastes such as urea
   B) nutrients such as glucose
   C) alcohol
   D) anesthetics
   E) all of the above

116. A low secretion of lutenizing hormone (LH) in the normal male adult would directly cause;
   A) shrinkage of the anterior pituitary gland
   B) excessive beard growth
   C) decreased testosterone secretion
   D) increased spermatogenesis
   E) decreased spermatogenesis

117. Which of the following structures is incorrectly paired with its function?
   A) oviduct -- site of normal embryonic implantation
   B) seminal vesicles -- add sugar and mucus to semen
   C) placenta -- maternal and fetal exchange organ
   D) prostate gland -- adds alkaline substances to semen
   E) epididymis -- maturation and temporary storage of sperm

118. In the process of hearing, the basilar membrane vibrates. Which event occurs next?
   A) tympanic membrane vibrates
   B) bones in middle ear amplify and conduct vibrations
   C) cochlear nerve transmits impulses to the organ of Corti
   D) hair cells in organ of Corti are stimulated
   E) vibrations conducted to chemoreceptors

119. The order in which light reaches the lens of a human eye is;
   A) pupil, cornea, aqueous humor, lens
   B) lens, aqueous humor, pupil, lens
   C) cornea, aqueous humor, pupil, lens
   D) cornea, pupil, aqueous humor, lens
   E) cornea, vitreous humor, pupil, lens

120. You observe an organism with the following characteristics: parthenogenetic reproduction, internal development of embryos, presence of an amnion, lack of parental care of young. Of the following, the organism is probably a (an);
   A) earthworm
   B) lizard
   C) bird
   D) frog
   E) mammal

End of Test
Merck State Science Day 2006

Answer Section

MULTIPLE CHOICE

1. ANS: B
2. ANS: D
3. ANS: D
4. ANS: D
5. ANS: A
6. ANS: D
7. ANS: C
8. ANS: B
9. ANS: E
10. ANS: C
11. ANS: C
12. ANS: D
13. ANS: A
14. ANS: C
15. ANS: B
16. ANS: D
17. ANS: C
18. ANS: D
19. ANS: C
20. ANS: C
21. ANS: B

Questions only refers to the electron movement: not the order of the steps of cellular respiration.

22. ANS: C
23. ANS: B
cross-over is in prophase I and independent assortment is in metaphase I

24. ANS: A
25. ANS: C
26. ANS: B
27. ANS: B
28. ANS: A
29. ANS: B
30. ANS: A
31. ANS: E
32. ANS: C
33. ANS: A
34. ANS: B
35. ANS: B
36. ANS: D
37. ANS: E
38. ANS: D
39. ANS: E
40. ANS: D
d. higher fungi groups lack a flagellated spore

41. ANS: C
42. ANS: B
   eight haploid spores indicates sexual reproduction - eliminates the deuteromycetes

43. ANS: C
44. ANS: B
45. ANS: B
46. ANS: D
   DNA reads 3’ -> 5’: does not code the promoter, so starts on the bottom strand at TAC which codes for MET and continues to the ATC (codes for UAG = stop is not an amino acid)

47. ANS: B
48. ANS: D
   Stomates would close = no evapotransiration, which is a cooling process would occur - so the temperature would increase: water uptake slows, photosynthesis decrease (reduced gas exchange) and less water for the pressure-flow gradient

49. ANS: C
50. ANS: B
51. ANS: C
52. ANS: E
53. ANS: C
54. ANS: B
55. ANS: B
56. ANS: E
57. ANS: D
58. ANS: C
59. ANS: D
60. ANS: C
61. ANS: E
62. ANS: E
63. ANS: B
64. ANS: E
65. ANS: B
66. ANS: D
67. ANS: A
68. ANS: B
69. ANS: E
70. ANS: A
71. ANS: C
72. ANS: D
73. ANS: D
74. ANS: D
75. ANS: A
76. ANS: E
77. ANS: D
78. ANS: C
79. ANS: C
80. ANS: A
81. ANS: C
82. ANS: D
83. ANS: D
84. ANS: C
85. ANS: C
86. ANS: D
87. ANS: E
88. ANS: D
89. ANS: A
90. ANS: C
91. ANS: A
92. ANS: A
93. ANS: A
94. ANS: D
95. ANS: C
96. ANS: A
97. ANS: B
98. ANS: D
99. ANS: A
100. ANS: E
101. ANS: C
102. ANS: B
103. ANS: D
104. ANS: C
105. ANS: E
106. ANS: A
107. ANS: C
108. ANS: B
109. ANS: C
110. ANS: D
111. ANS: B
112. ANS: A
113. ANS: D
114. ANS: C
115. ANS: A
116. ANS: C
117. ANS: A
118. ANS: D
119. ANS: C
120. ANS: B