

Multiple choice questions – 2 points each (single best answer for each).

1. A cell is composed of compounds that include proteins, nucleic acids, lipids, and carbohydrates. A cell is capable of reproduction, but when the compounds of the cell are isolated, none of them can reproduce. Therefore, cell reproduction is an example of ...
- A. Growth
 - B. A molecule
 - C. An emergent property
 - D. Adaptation
 - E. Metabolism
2. Louis Pasteur designed an experiment using the swan-necked flask to prove that:
- A. Bacterial organisms cannot be killed by heat
 - B. Life does not arise spontaneously from nonliving matter
 - C. Earth was really much older than people of the time thought
 - D. The half-life of uranium²³⁸ is 10 billion years
 - E. Maggots grow in meat
3. In sugar cane (a C₄ plant), CO₂ is released for use in the Calvin-Benson cycle: **Extra Credit**
- A. In the bundle sheath cells
 - B. During the evening
 - C. In glucose molecules
 - D. In the stroma
 - E. None of the above
4. The reduction of pyruvate to lactic acid during fermentation allows glycolysis to continue in the absence of oxygen. Why?
- A. This reaction is coupled to the electron transport system
 - B. This reaction is coupled to the oxidation of FADH₂ to FAD⁺
 - C. This reaction is coupled to the oxidation of NADH + H⁺ to NAD⁺
 - D. This reaction is coupled to the formation of ATP
 - E. This reaction is coupled to the reduction of NAD⁺ to NADH + H⁺
5. One of the following biologically important macromolecules is NOT a polymer in the same sense as the other three, which molecule is it?
- A. Nucleic acids
 - B. Proteins
 - C. Lipids
 - D. Polysaccharides

6. The evolutionary biology concept of “rust the crust” refers to the idea that:
- A. Iron is necessary for the cytochromes in the respiratory chain
 - B. Iron gets used in hemoglobin
 - C. Iron had to get oxidized before oxygen could exist in the atmosphere
 - D. Iron is needed for the biosynthesis of polymers
 - E. Iron is the fourth most abundant element on Earth
7. During the citric acid cycle, which compound has the most available free energy, i.e., is the most reduced?
- A. Citrate
 - B. Succinate
 - C. Fumarate
 - D. Oxaloacetate
 - E. Succinyl-CoA
8. The enzyme that charges the tRNA molecules with appropriate amino acids and thereby acts as the universal code translator is:
- A. tRNA isomerase
 - B. amino-tRNA chargeatase
 - C. reverse transcriptase
 - D. aminoacyl-tRNA synthetase
 - E. tRNA primase
9. For photosystem II, after electron excitation, what compound gets reduced first in the electron transport chain?
- A. Plastoquinone
 - B. Ferredoxin
 - C. Pheophytin-I
 - D. Plastocyanin
 - E. Cytochrome complex
- 10. Why are the absorption spectrum of chlorophyll a and the action spectrum of photosynthesis not identical? Question Dropped**
- A. Accessory pigments contribute energy to drive photosynthesis.
 - B. Chlorophyll a absorbs both red and blue light.
 - C. Chlorophyll a reflects green light.
 - D. Different wavelengths of light have different energies.
 - E. Chlorophyll a can be activated by absorbing a photon of light.
11. How many moles of ATP are generated for each mole of acetyl-CoA introduced into the citric acid cycle strictly by substrate-level phosphorylation?
- A. 1
 - B. 2
 - C. 3
 - D. 4
 - E. 6

12. When carbon dioxide is added to RuBP, the first stable product synthesized is?
- A. Pyruvate
 - B. Glyceraldehyde 3-phosphate
 - C. 3-phosphoglycerate
 - D. ATP
 - E. Acetyl-CoA
13. What is, by far, the most abundant protein/enzyme found on the planet?
- A. ATP synthase
 - B. RuBisCo
 - C. Isocitrate dehydrogenase
 - D. Phosphofructokinase
 - E. aminoacyl-tRNA synthetase
14. Consider the rate limiting cellular process when it comes to the growth of cells. Which of the following is the rate limiting or slowest process for *Bacteria*, *Archaea*, and *Eucarya* cells?
- A. replication
 - B. transcription
 - C. translation
 - D. translocation
 - E. transformation
15. Prion diseases like “mad cow disease” are caused by which of the following?
- A. Erroneous chaperonins
 - B. Loss of control by Cyclin-Cdk complexes
 - C. Receptor-mediated endocytosis
 - D. Mutation of pseudogenes
 - E. Sexually transmitted viruses
16. Consider the structure and function of the chromosome, which of the following is NOT involved during the organization of chromatin material?
- A. Histones
 - B. Mesosomes
 - C. Cohesins & condensins
 - D. Nucleosomes
 - E. Looped domains
17. During respiration, which of the following zones becomes more acidic (i.e., increased in protons)?
- A. thylakoid space
 - B. matrix
 - C. inter membrane space
 - D. mesosome
 - E. cytoplasm

18. In *Eucarya* cells, where are proteins that are initially guided by signal recognition particles translated?
- A. nucleus
 - B. Golgi apparatus
 - C. mitochondria
 - D. endoplasmic reticulum
 - E. cytoplasm
19. When a plant cell is placed in an isotonic solution, which of the following occurs?
- A. The cell takes up water until balanced by the pressure potential of the cell wall
 - B. The cell takes up water and eventually bursts
 - C. The cell shrinks away from the cell wall
 - D. There is no net movement of water into or out of the cell
 - E. Water moves into the cell
20. Consider the features of gene expression and control in *Eucarya*, which of the following is NOT a true statement?
- A. Eucarya have multiple RNA polymerases.
 - B. Eucarya have complex transcription factors.
 - C. Eucarya have both local and distal control elements.
 - D. Eucarya have sets of multiple genes under operon control.
 - E. Eucarya have to contend with chromatin structure.
21. Phosphofructokinase (PFK) is an important control enzyme. The following features correspond to this enzyme EXCEPT:
- A. It produces fructose 6-phosphate
 - B. It is inhibited by ATP & citrate
 - C. It is activated by ADP & AMP
 - D. It modulates the rate of the glycolysis
 - E. It is an allosteric enzyme
22. In cyclic photosynthesis, electrons are transferred back into the cytochrome complex by which of the following? **Question Dropped**
- A. ATP
 - B. NADPH + H⁺
 - C. Ferredoxin
 - D. Plastocyanin
 - E. Hydrogens liberated by the splitting of a water molecule

23. Structures that contain networks of keratin fibers and hold adjacent cells together are called:

- A. Extracellular matrices
- B. Glycoproteins
- C. Gap junctions
- D. Desmosomes
- E. Phospholipid bilayers

24. In photosynthesis, electrons from which ultimate source replenish chlorophyll molecules in both P₆₈₀ & P₇₀₀ that have given up excited electrons? **Question Dropped**

- A. Carbon Dioxide
- B. Water
- C. NADPH + H⁺
- D. Oxygen
- E. ATP

25. Animals inhale air-containing oxygen and exhale air with less oxygen and more carbon dioxide. Later, the oxygen from the air will most likely be found in....

- A. The carbon dioxide that is exhaled
- B. Water
- C. Organic molecules
- D. Ethanol
- E. Lactate

26. Which of the following features summarizes the molecular architecture of DNA?

- A. The two strands run in opposite directions
- B. The molecule twists in the same direction as the threads of most screws (RT-handed)
- C. The molecule is a double-stranded helix
- D. DNA has a uniform diameter
- E. All of the above

27. The enzyme that removes the RNA primers is called...

- A. DNA ligase
- B. primase
- C. reverse transcriptase
- D. helicase
- E. DNA polymerase I

28. The TATA box is:

- A. a sequence rich in A's and T's common to the promoter region of many genes
- B. an operator site that aids in the regulation of transcription
- C. an enhancer consensus sequence
- D. an activator sequence necessary for proper translation
- E. a corepressor sequence needed for translocation

Matching Questions - 1 point each. Indicate if the following reactions occur in (A) photosynthesis only, (B) respiration only; or (C) both photosynthesis AND respiration.

29. _____ ATP synthesis by chemiosmosis
30. _____ fixation of carbon dioxide
31. _____ electron flow along a cytochrome complex
32. _____ substrate level phosphorylation
33. _____ oxidation of water

More Matching – 1 point each. Use single best answer to match the organelle with the characteristic/process that is best described or associated with it. The possible answers are: (A) Ribosomes, (B) Mitochondria, (C) Lysosome, (D) Nucleus, and (E) Chloroplast.

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|-----------|---------------------|-----------|---------------|
| 34. _____ | snRNPs | 39. _____ | Phagocytosis |
| 35. _____ | Translation | 40. _____ | Transposition |
| 36. _____ | Histone Acetylation | 41. _____ | Transcription |
| 37. _____ | RuBisCo | 42. _____ | Matrix |
| 38. _____ | DNA replication | 43. _____ | Stroma |

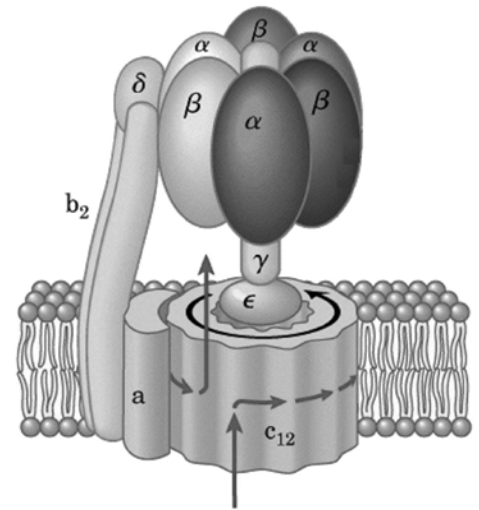
More Matching – 1 point each. Match the proper catabolic stage of glucose catabolism. The possible answers are (A) Glycolysis, (B) Oxidation of Pyruvate to Acetyl-CoA, (C) Citric Acid Cycle; (D) Oxidative Phosphorylation, (E) Respiratory or Electron Transport Chain.

44. _____ At which stage does NAD^+ first get reduced to $\text{NADH} + \text{H}^+$?
45. _____ At which stage is the carbon skeleton of glucose split?
46. _____ At which stage do hydrogen ions (i.e., protons) diffuse down a gradient?
47. _____ At which stage in aerobic respiration is the first molecule of CO_2 produced?
48. _____ At which stage does FAD^+ first get reduced to FADH_2 ?

More Matching – 1 point each. Match the single best letter of the correct subunit(s) with its respective function for ATP synthase.

Your choices are:

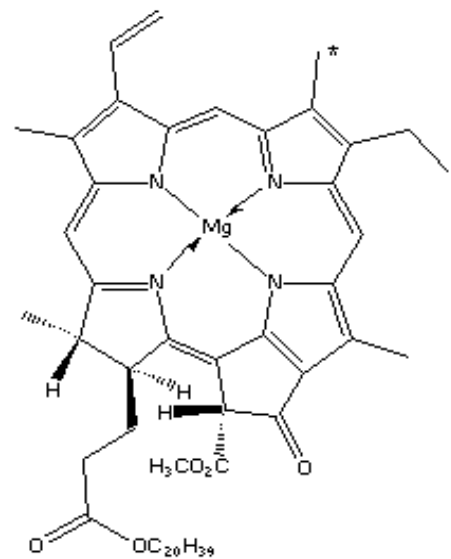
- (A) a, δ and b_2 subunits
- (B) β subunits (F_1 head)
- (C) c_{12} subunits (F_0 stalk)
- (D) γ subunit
- (E) ϵ subunit



- 49. _____ Catalytic site for ATP synthesis.
- 50. _____ Asymmetrically shaped subunit that transforms rotational energy into a conformational change of the catalytic site.
- 51. _____ These form a hydrophilic pore for protons to go through.
- 52. _____ These turn as protons flow through.
- 53. _____ Stator apparatus.
- 54. _____ Has three different possible conformations.
- 55. _____ Turns 120° per proton pumped.
- 56. _____ Electrochemical gradient forces these to turn and thus complete half-channels.

Short answer – Number of points in parentheses.

57. (4 points) The structure on the right is the only biological molecule visible from space (true factoid!). (A) What is the function of the porphyrin-based structure shown?



(B) What protein complexes contain this structure, and where are they located in the cell?

True or False – (2 points each)

58. _____ Respiration transfers electrons from carbon to oxygen.
59. _____ Photosynthesis reduces carbon. Respiration oxidizes carbon.
60. _____ Electron micrographs have shown that mitochondria in heart muscle have a higher density of cristae than mitochondria in skin cells.
61. _____ After an electron has been removed (by light energy) from the special pair of chlorophylls in photosystem II, those chlorophylls are more electronegative than O₂.
62. _____ Plants do photophosphorylation only during the daytime and oxidative phosphorylation only at night.

Short answer – Number of points in parentheses.

63. **(4 points)** Two different diffusible electron carriers (ubiquinone and cytochrome C) shuttle electrons between the three protein complexes of the electron transport chain in the inner membrane of the mitochondria. Could, in principle, the same diffusible carrier be used for both steps? Explain your answer in terms of reduction potentials.
64. **(6 points)** Consider issues that relate to photorespiration. **(A)** What is the waste product generated during photorespiration?
- (B)** Under which conditions does this happen?
- (C)** What enzyme is responsible for it, and why (evolutionarily speaking)?
- (D)** Why might it be relevant when considering the effects of elevated CO₂ on the biosphere?

Short answer – Number of points in parentheses.

65. (6 points) (A) Name the **two** different phases of the Calvin cycle that each contain a step where a particular molecule gets **two** phosphate groups attached. **Extra Credit.**

(B) Describe the step and/or enzyme within each of these phases where this step occurs.

(C) Why are these two steps so critically important to this pathway.

66. (6 points) Consider **negative** operon control. **(A)** Name a pathway that undergoes this type of control.

(B) What is the repressor made from?

(C) What is the operator made from?

(D) How does the repressor cause negative control to occur?

67. Extra Credit (6 points max) **(A)** How many ATP-equivalents are contained within a glucose when considering aerobic respiration with optimal conditions? **(B)** How many ATP-equivalents does it take to build a glucose from scratch using optimal “light-independent” methods? **(C)** Why is there such a large difference between these two numbers?