Multiple Choice Test: Membranes, Molecules and Mitochondria

ASHA Lectures

Movement Across a Membrane:

1. Oestrogen is a relatively small steroid hormone associated with the development and maintenance of biologically female characteristics, including the menstrual cycle. The molecule itself is lipophilic and non-polar. The most likely way that this molecule crosses the plasma membrane is:

    a. Simple Diffusion

    b. Facilitated Diffusion

    c. Active Transport

    d. Endocytosis

Explanation: Molecules that are small and lipophilic can directly cross the membrane without any additional support. It is therefore most likely that Oestrogen, as a small and lipophilic membrane, will cross the membrane directly via simple diffusion.

2. Ethanol is a very small non-polar molecule with a small polar end. The most likely way ethanol enters the cell via the plasma membrane is:

    a. Through a carrier protein

    b. Via endocytosis

    c. Directly through the plasma membrane

    d. Via active transport

WEB: https://ashalectures.org/
EMAIL: asha.lectures@gmail.com

Explanation: Similar to 1, except in this case ethanol has a small polar end. As ethanol ticks most of the requirements for direct transport across a membrane and is only partially polar – most likely it is has little trouble directly crossing the plasma membrane.

3. The role of the plasma membrane surrounding organelles is:

    a. Compartmentalise related chemical reactions to specific regions of the cell

    b. Regulate substances into and out of the cell

    c. Signal to other cells that the cell they're in is undergoing oxidative stress

    d. Contain cholesterol for later use in the production of steroid hormone

Explanation: The role of any plasma membrane, including the plasma membrane surrounding organelles is to regulate substances in and out of the membrane. In the case of the cell membrane, this separates the inside of the cell (and the types of reactions that happen inside the cell) from the outside of the cell. In the case of the organelle membrane, it separates reactions which the organelle performs, from reactions which other organelles perform.

4. The export of a protein once it is translated requires the presence of:

    a. Mitochondria

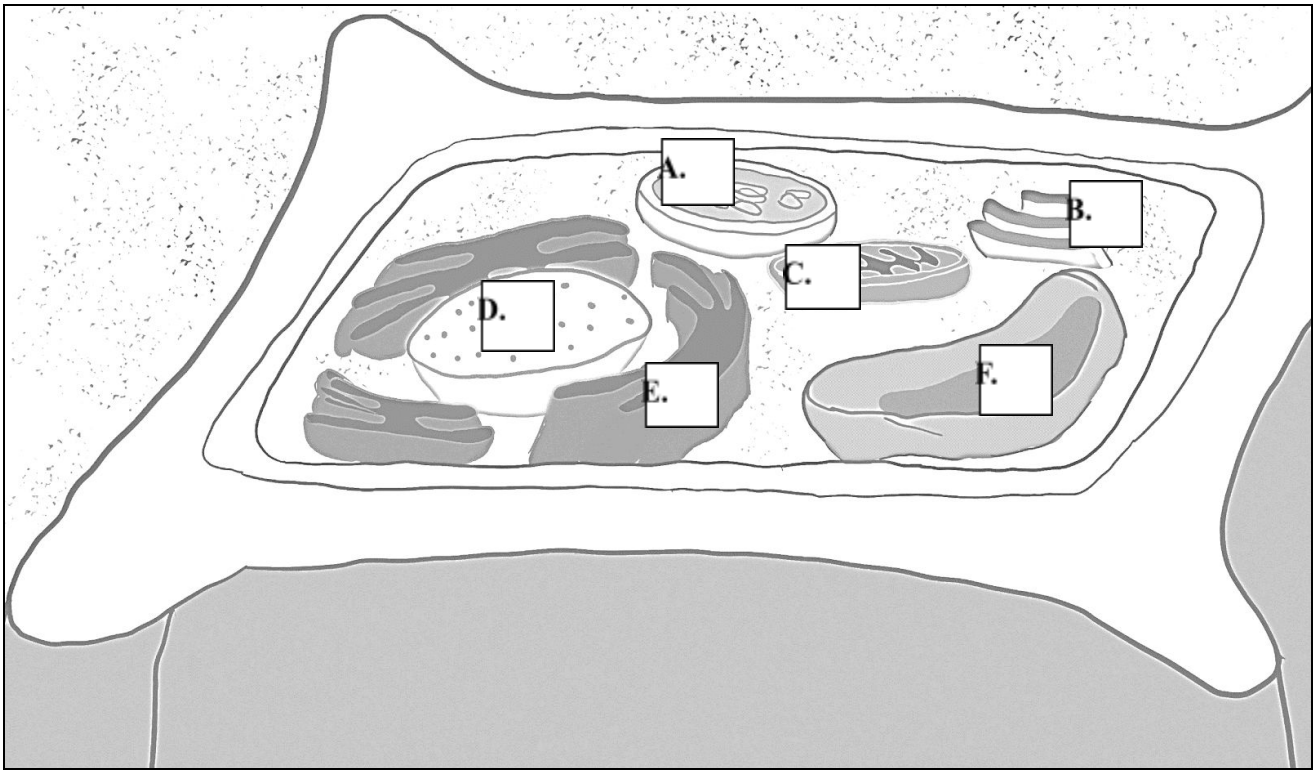
    b. Membrane Proteins

    c. Double membrane

    d. Nucleus

Explanation: Protein export typically involves exocytosis and thus energy. Where is that energy coming from? The mitochondria.

5. Consider Figure 1. Below, a simplified drawing of a plant cell. Each letter labels an organelle important in the synthesis and export of a protein.



The organelle responsible for packaging and modifying proteins for transport outside the cell is:

A.
B.
C.
D.
E.

Explanation: The Golgi Apparatus (B) is responsible for packaging, sorting and modifying proteins for export from the cell. It is typically found near the plasma membrane.

6. Still considering Figure 1, the order of organelles involved in the transcription, synthesis and export of a protein is:

   a. A → B → C → D

   b. D → A → C → B

c. D → E → C

d. D → E → B

Explanation: The full steps in protein transcription, synthesis and export is:

- Transcription (in the Nucleus) (D)
- Translation (at the Ribosome)
- Movement within the cell to Golgi Apparatus (at the Endoplasmic Reticulum) (E)
- Modification, Packaging and Sorting (at the Golgi Apparatus) (B)
- Export from the cell (Vesicles, exocytosis)

Hence, (D) (E) (B) is the order of the organelles involved (which are depicted in the diagram).

7. The role of the double plasma membrane around chloroplast in plants is to:

   a. Regulate the movement of materials into and out of the cell

   b. Regulate the movement of sugar into and out of the chloroplast

   c. Regulate the amount of light in the chloroplast

   d. Allow the chloroplast to act separately from the plant cell

Explanation: The role of a membrane is to regulate the movement of substances across it. Hence, the role of the chloroplasts membrane is to regulate the movement of substances, including sugar (which is produced in photosynthesis), into and out of the chloroplasts . Be careful here, there's a difference between why something exists and what it is used for!

8. To predict the method of movement a molecule will take across a membrane into a cell you must consider:

   a. Charge and Size of the molecule

   b. Charge, Polarity, and Size of the molecule

   c. Charge, Polarity and Size of the molecule, and the concentration gradient

   d. Charge, Polarity and Size of the molecule, and the direction of movement

Explanation: Charge, Polarity and Size will help you determine whether a substance can directly cross a membrane. However, you still need the concentration gradient to work out whether energy is required. If you go against the concertation gradient, then it will always be an active form of movement across a membrane.

9. Pinocytosis:
    a. Occurs when cells have insufficient water
    b. Is a method of bulk transport
    c. Is the passive movement of liquids across the plasma membrane
    d. Requires digestive enzymes

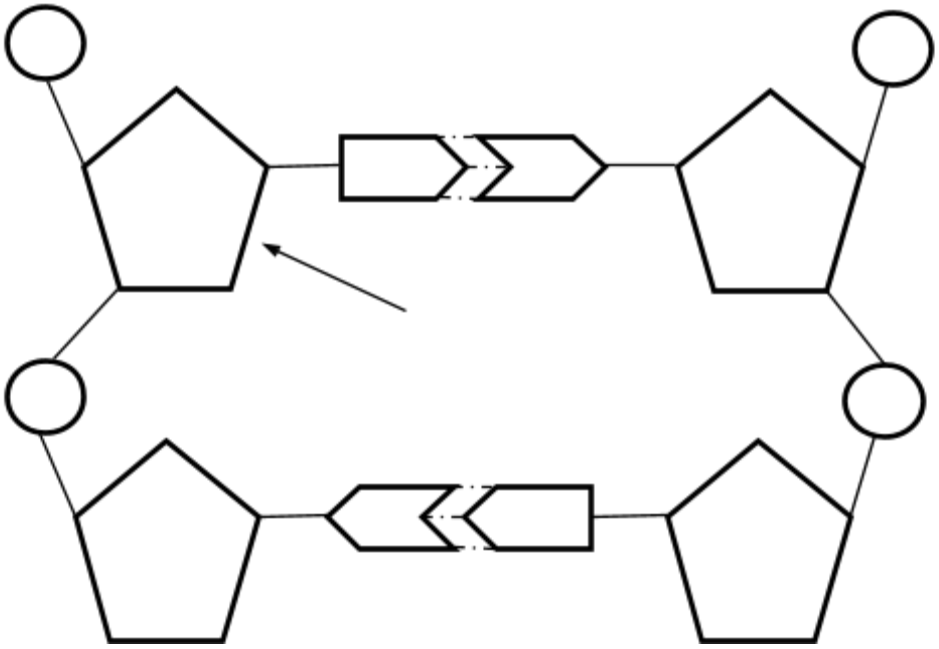
Explanation: Pinocytosis is a form of endocytosis, and thus bulk transport. It requires energy, and is thus an active process. It occurs all the time, not just when cells have insufficient water.

10. Small non-polar molecules usually enter cells via simple diffusion. This is because:
    a. The plasma membrane is semi-permeable
    b. Non-polar molecules are not repelled by the lipophilic tails of the phospholipid molecules
    c. Only small molecules are able to pass through instantaneous gaps in phospholipid molecules created by the plasma membranes fluidity
    d. Both b and c

Explanation: The plasma membrane being semi-permeable just means it is selective about what can cross. (b) and (c) give full explanations for why small and non-polar molecules are able to directly cross the membrane.

Proteins and Nucleic Acids:

11. Molecule X is a monomer in the non-circular polymer shown below. It is most likely a monomer of which polymer:



X

a. mRNA

b. A polypeptide

c. Nuclear DNA

d. mtDNA

Explanation: The way this molecule is depicted, it seems to be double stranded. Hence, it is likely some form of DNA rather than mRNA. mtDNA (mitochondrial DNA) is similar to prokaryotes, and thus is circular (and the question says it's not circular). Hence, molecule X is likely a nucleotide of nuclear DNA (i.e. DNA that is found in the nucleus).

12. Molecule X is found in what region/s of the cell:

a. Nucleus only

b. Endoplasmic reticulum only

c. Nucleus and Mitochondria

d. Nucleus, Mitochondria and Chloroplast

Explanation: DNA nucleotides (careful here – we are talking about the monomer and not the polymer as in the previous question) are found in mitochondrial DNA, nuclear DNA and chloroplast DNA. Hence molecule X, a nucleotide monomer, is found in the mitochondria, nucleus, and chloroplast.

13. Groups of 3 monomers of molecule X are called:

a. Triplets

b. Codons

c. Anticodons

d. Base pairs

Explanation: A group of three nucleotides is called a triplet in DNA, a codon in mRNA and an anticodon in tRNA. Here, we are discussing DNA so it is a triplet.

14. ATP, mRNA and DNA are very important molecules in the functioning of the cell. They all:

a. Code for the production of specific polypeptides

b. Are important in translation

c. Contain nucleotide polymers

d. Are required for the production of enzymes involved in cellular respiration

Explanation: ATP, mRNA and DNA all contain nucleotide monomers, not polymers. DNA is not important in translation, but transcription. All three however are important in making proteins (and hence enzymes), as DNA needs to encode the polypeptide, mRNA needs to send this code to the ribosomes and translation requires energy (i.e. ATP).

15. In the process of synthesising polypeptides, amino acid molecules are bonded together by peptide bonds. The formation of these bonds requires energy in the form of:

    a. Glucose

    b. Heat

    c. Unloaded coenzymes

    d. Specific coenzymes

Explanation: Energy is always in the form of ATP in Biology. And ATP is a loaded, specific coenzyme.

16. Y is a protein comprising of 3 polypeptide chains. Each of these polypeptide chains was formed as a result of:

    a. Hydrolysis reaction between amino acid monomers

    b. Catabolic Reaction

    c. Condensation polymerisation reaction

    d. Transcription

Explanation: Polypeptides are formed when amino acids bind together in a reaction called condensation polymerisation.

17. The overall specific 3D shape of Y, a protein mentioned in the previous question enables it to bind to the operator region of a specific DNA sequence. This specific shape

a. Forms instantaneously

b. Requires energy to maintain

c. Has a complementary shape to the specific DNA sequence

d. Is always denatured by the presence of an acid

Explanation: The tertiary structure of a protein does not necessarily form instantaneously, or spontaneously (i.e. without energy), although sometimes it can. It doesn't require energy to maintain it is shape. If the role of a particular protein is to bind to a specific DNA sequence, then it's shape will be complementary to this DNA sequence. You can think of it like an enzyme binding to a substrate – in fact this is exactly what happens with restriction enzymes (something you'll learn about in Unit 4)! Also – hint – if an answer say always, or never, its typically wrong!

18. The highest level of structure protein Y has is:

a. Primary Structure

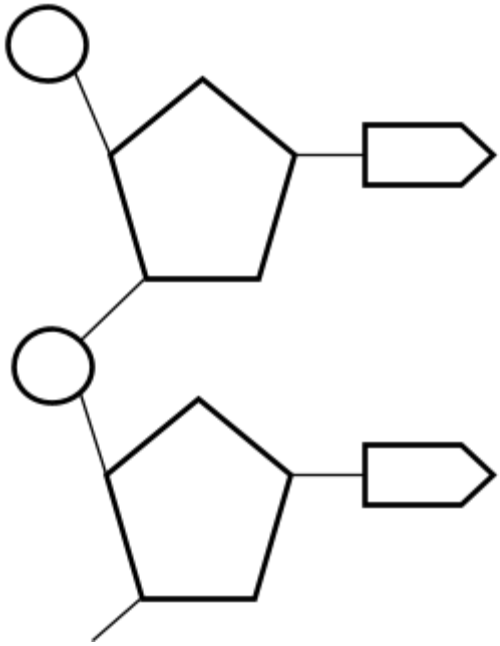
b. Secondary Structure

c. Tertiary Structure

d. Quaternary Structure

Explanation: Protein Y is made of multiple polypeptide chains, and hence has a quaternary structure.

19. The diagram below is simplistic representation of a biologically significant molecule, named molecule A. Which of the following must be true about molecule A?



a. Molecule A codes for the production of a specific protein

b. Molecule A contains lipid monomers

c. Molecule A is found in the nucleus of the cell

d. Molecule A is a polymer

Explanation: From the diagram, it's hard to tell whether molecule a is RNA or DNA. Answer a, would only be true if it were DNA – and additionally only if that DNA molecule was a gene. Neither RNA or DNA contains lipid monomers. Answer c. would be true for DNA, and mRNA – but not rRNA or tRNA. Answer d. however is true for all nucleic acids, and is thus the answer.

Cellular Respiration and Photosynthesis:

20. Which of the following is true about cellular respiration?

    a. Oxygen is an input in the Krebs Cycle

b. Only glucose is an input in glycolysis

c. It occurs in the cytosol of the cell

d. It is a biochemical pathway

Explanation: Oxygen is required for the Kreb's Cycle to start – but is not an input. NAD+ is another input in glycolysis, other than glucose. Aerobic cellular respiration occurs in the mitochondria and not the cytosol. Both cellular respiration and photosynthesis are biochemical pathways.

21. (The following relates to questions 21-23) A researcher is conducting an experiment on cellular respiration. She uses a beaker containing mitochondria taken from plant cells and water as a solvent. The temperature, oxygen levels and pH of this beaker is kept constant to ensure the mitochondria and required mitochondrial enzymes are not damaged. If this researcher then added acetyl-CoA molecules to the beaker, what would be the expected product?

    a. Lactic Acid

    b. Ethanol

    c. Carbon Dioxide

    d. None

Explanation: The acetyl-CoA is able to enter the Kreb's Cycle in the mitochondria, and then into the electron transport chain. One of the products from this reaction is Carbon Dioxide.

22. If instead of acetyl-CoA, the researcher had added glucose to the beaker, what would you expect to see?

    a. Bubbling as a gas was produced

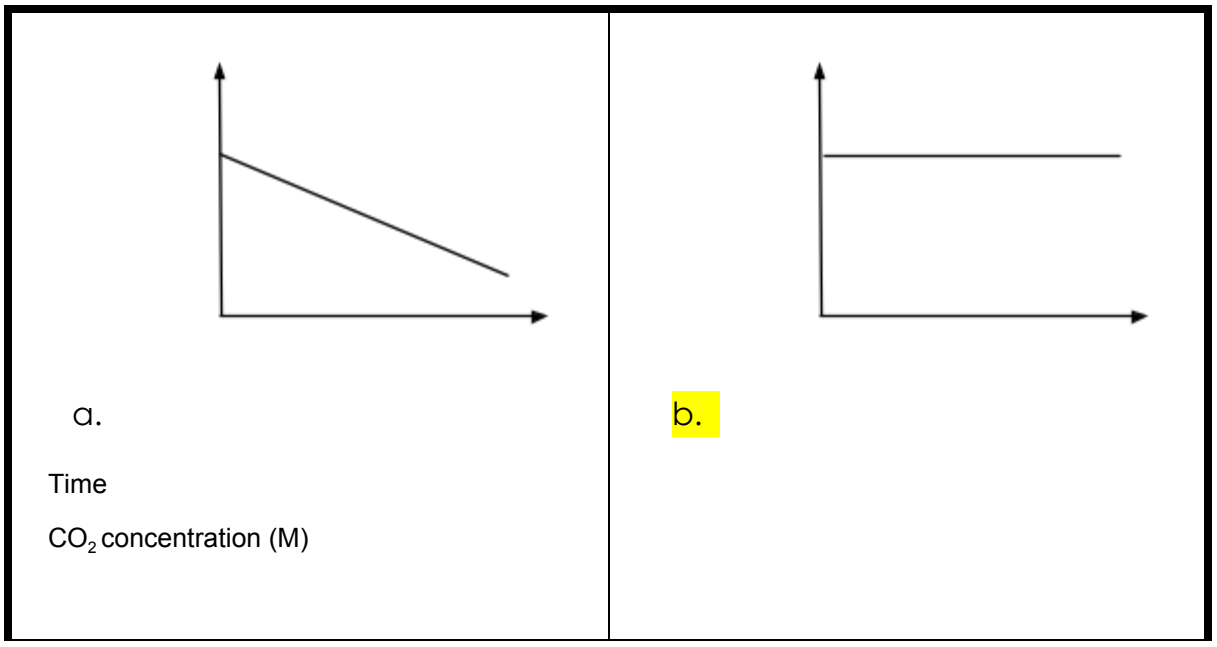
    b. The production of ethanol

    c. Both a and b

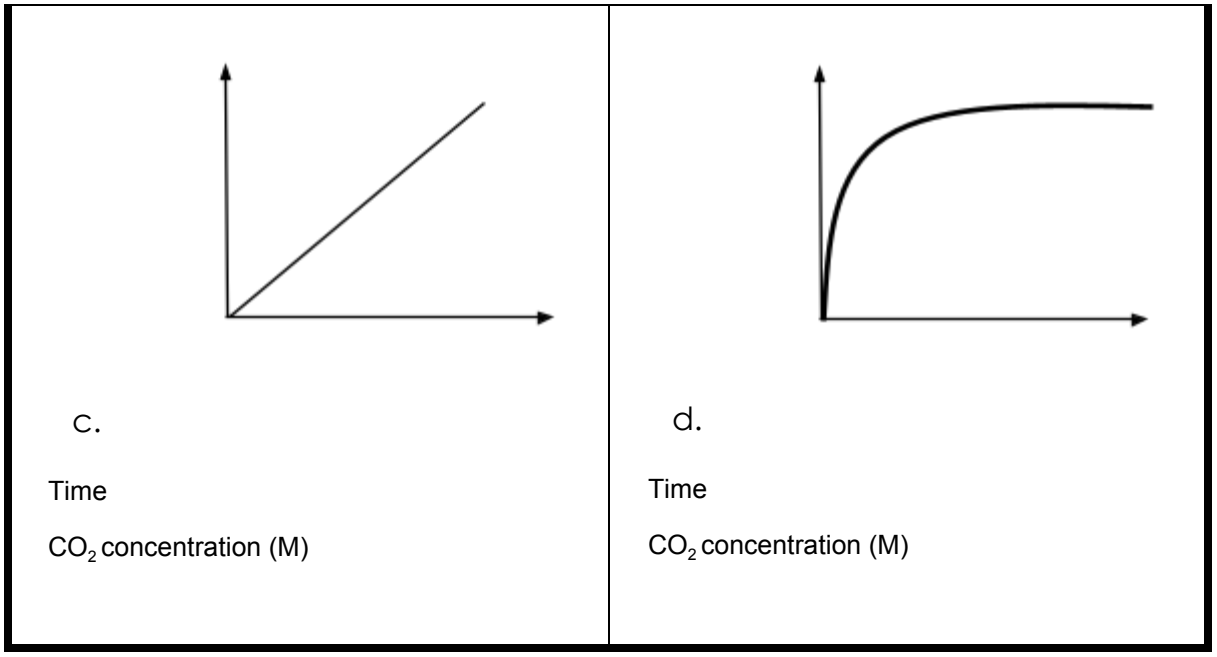
d. Nothing

Explanation: There's no cytosolic enzymes in the beaker (did you notice we only introduced mitochondria and not cells, or the cytosol from cells?). These are the enzymes which catalyse glycolysis, so without them neither aerobic or anaerobic respiration can occur.

23. If the researcher had added glucose to the beaker, what would you expect the graph of the concentration of carbon dioxide against time to look like?



WEB: https://ashalectures.org/
EMAIL: asha.lectures@gmail.com



Explanation: As no reaction is happening (see the previous question), there should be no change to the concentration of carbon dioxide over time.

24. In photosynthesis:

    a. NADPH is used to provide energy for the light independent phase of photosynthesis

    b. The light required is captured by enzymes in the stroma

    c. ATP is produced by the light dependent phase

    d. Glucose is the only ever the sugar produced

Explanation: ATP is an output of the light dependent stage of photosynthesis.

25. A cell has insufficient oxygen to undergo aerobic respiration. This cell will then:

    a. Undergo anaerobic respiration until it undergoes apoptosis

    b. Break down pyruvate into lactic acid

c. Recycle loaded coenzymes

d. Produce ethanol

Explanation: If a cell cannot undergo aerobic respiration it will undergo anaerobic respiration. Anaerobic respiration recycles loaded coenzymes. I.e. it takes the NADH from glycolysis (NADH is a loaded coenzyme) and recycles it into its unloaded form NAD+.

26. It is believed that the presence of mitochondria in modern day eukaryotes is a result of an evolutionary symbiotic relationship between an ancient prokaryotic organism and an ancestor of modern eukaryotes. What is considered evidence of this theory?

    a. Mitochondria have a very similar shape and colour to modern day bacteria

    b. Mitochondria do not contain enough DNA to code for all mitochondria-specific proteins

    c. Mitochondria enable cells to undergo aerobic respiration, a very useful and important process in eukaryotes

    d. Mitochondria have a double membrane

Explanation: Evidence of the endosymbiosis theory of mitochondria include: mtDNA is circular, the size / structure of mitochondrial ribosomes, and the double membrane surrounding the mitochondria.

27. During intense exercise, the body cells of athletes may undergo anaerobic respiration rather than aerobic respiration. Advantages of anaerobic over aerobic respiration include the:

    a. Amount of ATP produced, for the same amount of time

    b. Ability to continue to produce ATP without the presence of oxygen

    c. Recycling of coenzymes back into unloaded forms quickly

    d. All of the above

Explanation: Anaerobic respiration produces more ATP in the same time period. Aerobic produces more ATP in for the same amount of glucose. Aerobic respiration is also able to recycle NADH into NAD+ more quickly than anaerobic respiration, which has to undergo the electron transport chain to get NAD+ back.

28. During the light independent phase of photosynthesis loaded coenzymes are cycled back into their unloaded forms. One of these loaded coenzymes is:

    a. NADH

    b. NAD+

    c. NAPH

    d. NADP+

Explanation: A loaded coenzyme is one that is holding onto elections and H^+ ions. One loaded coenzyme which is recycled to its unloaded form (no H^+ ions and electrons) in the light independent phase is NAPH.

29. A student created a table of differences and similarities between aerobic and anaerobic respiration, shown below:

Which statements are correct?

    a. (A), (B), (D) and (E)

    b. (A), (B) and (E)

c. All except (F)

d. (A) and (E)

Explanation: (B) is wrong, anaerobic produces more ATP for the same time period (aerobic respiration produces more ATP for the same amount of glucose). (C) is wrong because both anerobic and anaerobic respiration happen in plant and animal cells. (D) is wrong because anaerobic respiration in animals doesn't produce carbon dioxide. (F) is wrong because aerobic cellular respiration

So, only (A) and (E) are correct.

30. Which one of these statements about photosynthesis is correct?
    a. It only occurs in plant cells
    b. It requires the presence of chlorophyll, which is found in the stroma
    c. The light independent stage occurs after the light dependent phase
    d. Temperature is an important factor in determining the rate of photosynthesis

Explanation: There are some non-plant organisms which undergo photosynthesis. Chlorophyll is not found in the stroma, but the thylakoid membrane. The light dependent and the light independent stages occur simultaneously, and not in any particular order. Reactions in photosynthesis are catalysed by enzymes. The rate of reaction regulated by enzymes is temperature dependent.

31. Unlike anaerobic respiration, aerobic respiration:
    a. Produces carbon dioxide
    b. Requires t activity of enzymes
    c. Produces ATP
    d. Doesn't produce an acid in animals

Explanation: In animals, anaerobic respiration produces lactic acid and aerobic respiration does not.

32. For the chemical reaction below, which of the following statements is true?

$$NADP^+ + H^+ + 2e^- \rightarrow NADPH$$

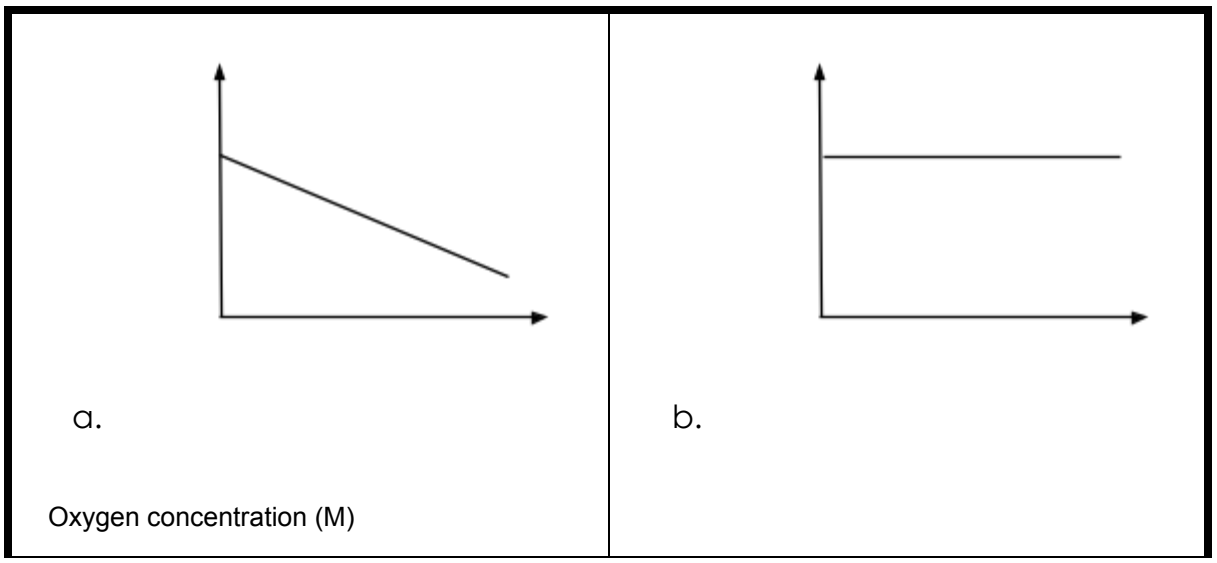
a. NADP+ is a coenzyme

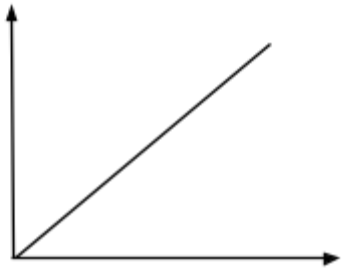
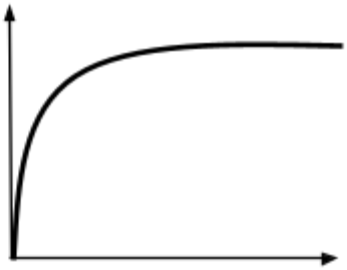
b. NADPH is utilised in cellular respiration

c. The reverse reaction occurs in the light dependent phase of photosynthesis

d. The reaction is required to move energy around the cell, between required reactions

33. The graph which best represents the rate of cellular respiration for a single cell as the concentration of oxygen increases is:



 c. Oxygen concentration (M)	 d. Oxygen concentration (M)

Explanation: This question is really about enzyme kinetics. Cellular respiration is catalysed by enzymes. Oxygen is a substance in aerobic cellular respiration. What happens to the rate of reaction when you increase the concentration of substrate? It increases until it reaches a saturation point (answer d), when all the active sites of the enzyme are occupied at any point of time.

34. The table that correctly identifies the main inputs and outputs for each stage of aerobic respiration is:

a.	Glucose, ADP, Pi, NAD^+	ATP, NADH	Pyruvate, ADP, Pi, NAD^+, FAD	CO_2, ATP, NADH, $FADH_2$	NADH, $FADH_2$, O_2, ADP, Pi	H_2O, ATP, NAD^+, FAD
b.						

WEB: https://ashalectures.org/
EMAIL: asha.lectures@gmail.com

c.						
d.						

Explanation: I would highly recommend you write a table out like for yourself! The most important things to take away from cellular respiration and photosynthesis is inputs, outputs and location for each of the stages! Also remember – every time ATP comes out of reaction, ADP and P_i must go in (and vice versa). And every time NAD^+ and FAD go into a reaction, FAH2 and NADH must come out (and vice versa). Knowing the numbers for inputs and outputs is only needed for ATP!