

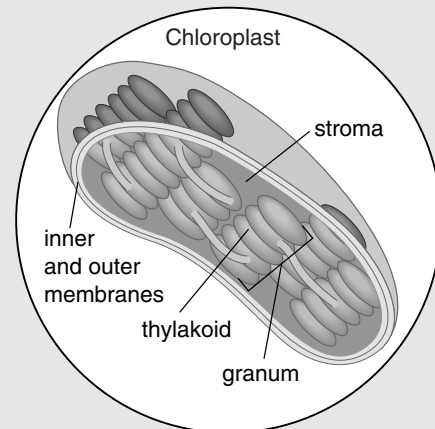
Unit 3 Review Answers

Student Textbook pages 198-199

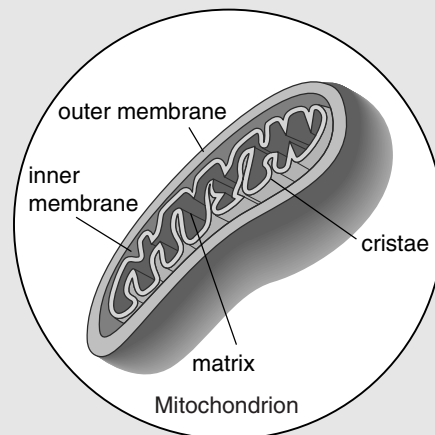
Answers to Understanding Concepts Questions

1. Autotrophic organisms are those that carry out photosynthesis. They contribute to an ecosystem by using solar energy to produce energy-rich compounds (carbohydrates). They also produce oxygen, which is released into the ecosystem.
2. Both autotrophs and heterotrophs release the energy stored in glucose by carrying out cellular respiration.
3. Cellular activities that require ATP include: ion transport across cell membranes; movement of chromosomes during cell division; movement of cilia and flagella; muscle contraction; and synthesis of carbohydrates, fats, proteins, and nucleic acids.
4. The breakdown and regeneration of ATP is a continuous cycle, which involves the cleavage of a terminal phosphate group in ATP to produce ADP (breakdown) and subsequent addition of a phosphate group to ADP to reform ATP.
5. The chloroplast is the organelle where photosynthesis takes place.

6. Students' sketches should resemble the structure depicted in Figure 5.4 of the student resource, including appropriately labelled structures.



7. In chloroplasts, grana are made of thylakoid disks.
8. In photosynthesis, NADPH is produced in the light-dependent reactions and is a source of reducing power (i.e., electrons) that is used in the light-independent reactions to synthesize carbohydrates. In cellular respiration, NADH, which is generated in glycolysis and the Krebs cycle, provides electrons that enter the electron transport chain for the synthesis of ATP.
9. Students' sketches should resemble the structure depicted in Figure 5.5 of the student resource, including appropriately labelled structures.



10. (a) Oxygen gas can be tested for by using a slow-burning, glowing splint of wood. The splint will burn faster and a flame will appear if oxygen is present.
(b) Carbon dioxide in water will result in the production of carbonic acid. This will cause the pH of the solution to decrease, which can be detected using a pH indicator such as bromothymol blue.
11. Metabolic pathways that synthesize large molecules from smaller ones require energy, while those that break down large molecules to smaller ones produce energy. Both types of pathways are catalyzed by enzymes.

12. Oxidation-reduction reactions are a central type of reaction in photosynthesis and cellular respiration. Products from these processes, such as ATP and carbohydrates, are required for numerous processes in organisms.
13. In the chloroplast, light energy is stored as chemical energy in glucose (matter). In the mitochondria, the glucose molecule is decomposed, releasing the energy which eventually is returned to the environment as heat.
14. Photosynthetic pigments are organic molecules capable of absorbing specific wavelengths of visible light. They act in photosynthesis by trapping energy from the Sun.
15. The light splits into its constituent colours, producing a spectrum. This spectrum could be used to study photosynthesis by controlling the colour a leaf is exposed to and measuring the rate of photosynthesis for each independent colour.
16. An action spectrum differs from an absorption spectrum in that an action spectrum describes how the rate of photosynthesis varies with wavelength of light absorbed, and an absorbance spectrum describes how individual pigments absorb light.
17. Photosystems are protein complexes that contain light-absorbing pigments. They are located on the thylakoid membrane.
18. The energy that is released at each step is stored temporarily in a hydrogen ion concentration gradient across the thylakoid membrane.
19. The electron for photosystem II is replaced through the splitting of water.
20. Water is the source for the oxygen released from chloroplasts during photosynthesis. Water is split, which releases hydrogen ions, oxygen, and electrons.
21. NADPH is formed from the reduction of NADP^+ , using electrons from photosystem I.
22. Reducing power means that the molecule has a strong tendency to donate electrons to other molecules. NADPH has a strong tendency to donate electrons (and thus hydrogen ions) to other molecules.
23. (a) Protons can only move through the ATP synthase enzyme complex.
(b) Chemiosmosis is the process associated with movement of hydrogen ions through ATP synthase, and results in the phosphorylation of ADP to produce ATP.
24. The reactions take place in the stroma of chloroplasts.
25. The Calvin-Benson cycle begins with carbon dioxide fixation, whereby carbon dioxide is incorporated into carbohydrates via reaction with ribulose biphosphate (RuBP). In order for a central compound called glyceraldehyde-3-phosphate (PGAL) to be synthesized the three-carbon compounds produced after carbon dioxide fixation must be activated by ATP and reduced by

NADPH. While some of the PGAL molecules are used for glucose synthesis, the majority are used to regenerate the RuBP that is required for carbon dioxide fixation and the continuation of the cycle.

26. The reactions of glycolysis take place in the cytosol of the cell (i.e., outside of the mitochondrion).
27. The products of glycolysis that contain useful energy are ATP, NADH, and pyruvate.
28. The burning sensation is caused by the build-up of lactic acid (lactate), produced by fermentation.
29. If fermentation begins with pyruvate, the products are NADP^+ , carbon dioxide, and ethanol.
30. Lactic acid is converted back to pyruvate, and it is metabolized as usual.
31. (a) From glycolysis pyruvate, ATP and NADH are produced.
(b) From the Krebs cycle carbon dioxide, NADH, FADH_2 , and ATP are produced.
(c) From electron transport, the energy generated is used to produce ATP in chemiosmosis.
32. The greatest numbers of ATPs are generated during electron transport.

Answers to Applying Concepts Questions

33. Student answers should include a proton concentration gradient, movement of the ions down the gradient through the ATP synthase complex, and phosphorylation of ADP to form ATP.
34. The set of reactions is called a cycle because one of the initial reactants (ribulose biphosphate) is regenerated through the set of reactions.
35. Glycolysis does not directly require oxygen for it to occur.
36. Yes it is correct because 2 ATP are required in the initial reactions converting glucose three-carbon intermediates. Thus, net result is a gain of 2 ATP.
37. Under those conditions fermentation occurs, whereby the pyruvate is converted to lactic acid.
38. Lack of oxygen prevents the last organic electron acceptor from getting rid of its electrons. This blocks the entire electron transport chain. With the chain blocked, NAD^+ cannot be regenerated. This stops those steps in the Krebs cycle that need NAD^+ in order to occur, and the cycle stops.
39. “Oxygen debt” describes the state where glycolysis is increased to such a point due to high energy demands (like intense exercise) that it exceeds the oxygen supply. It is “repaid” by blood transporting oxygen from the lungs.
40. (a) The stroma (chloroplast) fixes carbon while the matrix (mitochondrion) oxidizes acetyl CoA.
(b) Outer membrane: in plants, glucose moves out of the chloroplast, but in mitochondria, pyruvate moves into the mitochondria.

- (c) Either inner membrane or thylakoid membrane: If thylakoid membrane, the difference in function lies in the fact that ATP synthase is oriented in opposite directions. In chloroplasts, protons moving into the thylakoid can be used to create ATP. In mitochondria, protons moving out of the inner membrane can be used to make ATP.
- (d) Thylakoid membrane (see above).

- (b) The most active organelle would be considered to be the one generating the largest volume of gaseous product, which is the chloroplast.
- (c) Since the chloroplast suspension had a more significant drop in activity with a change from 5% to 15% DNP, the chloroplast is at more risk to changing DNP concentrations.

Answers to Making Connections Questions

41. In addition to glucose, plants produce many chemicals that they use to kill or discourage herbivores. These chemicals have been extracted from the plants and converted into medications, some of which are used in treating heart disease and cancer. As these species of plants disappear, so do the beneficial chemicals that they produce.
42. (a) A charged battery could represent ATP and a drained battery ADP; a controlled quantity of energy is delivered, and energy delivered does useful work.
- (b) An active solar system may be represented by solar panels, wind generation, or heat pumps. In the analogy, the original sources of energy must be identified, transfers described, and the tasks accomplished also described. The analogy must be reasonable. For example, the Sun is the source in both systems. The solar panel catches the light and converts it to electrical energy just like the chloroplast catches light and turns it into chemical energy. The energy in a solar system is transferred through wires. This is analogous to the ATP produced in photosynthesis. The electrical energy from the solar panel can be used to do many mechanical tasks just as the ATP can be used to accomplish many metabolic tasks.
43. Pyruvate is transferred from the cytosol to the inner matrix of the mitochondria during transition reactions in cellular respiration. Extra pyruvate would mean more could be sent into the mitochondria for formation of acetyl CoA, which may cause more oxidation in the Krebs cycle, and ultimately more ATP production. There is no logical way to explain weight loss from ingesting pyruvate. In fact, without dietary alterations or increased exercise, weight gain would be predicted.
44. Student answers should reflect the principal functions of photosynthesis that have been discussed in this unit. For example they may include: an ability to conduct photosynthesis outside of plant cells would increase glucose production; food could be produced anywhere, even in places where plants do not normally grow well; glucose production could be automated.
45. (a) The data indicating volume of $O_2(g)$ released is for the chloroplast.