

**Chapter 20****1) Pages: 758-759    Ans: C**

Which of these enzymes is *not* part of the Calvin cycle?

- A) Aldolase
- B) Glyceraldehyde 3-phosphate dehydrogenase
- C) **Phosphofructokinase-1**
- D) Ribulose-5-phosphate kinase
- E) Transketolase

**2) Pages: 764, 769    Ans: C**

The known mechanisms of activation of rubisco or of other enzymes of the Calvin cycle during illumination include all of the following *except*:

- A) increased stromal pH.
- B) light-driven entry of  $Mg^{2+}$  into the stroma.
- C) **phosphorylation by cAMP-dependent protein kinase.**
- D) phosphorylation of phosphoenolpyruvate carboxylase.
- E) reduction of a disulfide bridge by thioredoxin.

**3) Page: 765    Ans: B**

The assimilation of  $CO_2$  into organic compounds (triose phosphates) in green plants:

- A) involves condensation of the two-carbon compound acetate with  $CO_2$  to form 3-phosphoglycerate.
- B) **requires NADPH.**
- C) results in the production of ATP.
- D) takes place at equal rates in light and darkness.
- E) takes place in the cytosol.

**4) Page: 769    Ans: C**

In “C<sub>4</sub>” plants of tropical origin, the first intermediate into which  $^{14}CO_2$  is fixed is:

- A) aspartate.
- B) phosphoenolpyruvate.
- C) **oxaloacetate.**
- D) malate.
- E) 3-phosphoglycerate.

**5) Page: 771    Ans: B**

The synthesis of starch and sucrose in plants uses \_\_\_\_\_ as the substrate, rather than \_\_\_\_\_, which is used in the synthesis of glycogen in animal cells.

- A) ADP-fructose; UDP-glucose
- B) **ADP-glucose; UDP-glucose**
- C) fructose 1-phosphate; glucose 1-phosphate
- D) glucose 1-phosphate; glucose 6-phosphate
- E) UDP-glucose; ADP-glucose

**6) Page: 780 Ans: E**

Which one of the following reactions, cycles, or pathways is *not* found in plant systems?

- A) The Calvin cycle
- B) The gluconeogenesis pathway
- C) The glyoxalate cycle
- D) The rubisco reaction
- E) The urea cycle**

**7) Page: 754**

Show the reaction catalyzed by ribulose 1,5-bisphosphate carboxylase/oxygenase (rubisco).

**Ans:** Ribulose 1,5-bisphosphate + CO<sub>2</sub> → 2 (3-phosphoglycerate)

(For the details of the reaction, see Fig. 20-7, p. 756.)

**8) Page: 762**

Explain why both ATP and NADPH are required for the operation of the Calvin cycle, and why these two reactants are required in different amounts.

**Ans:** ATP is required in two reactions of the Calvin cycle: the formation of 1,3-bisphosphoglycerate from 3-phosphoglycerate (2 ATP per CO<sub>2</sub> fixed) and the conversion of ribulose 5-phosphate into ribulose 1,5-bisphosphate (1 ATP per CO<sub>2</sub> fixed). NADPH is required in the reduction of 1,3-bisphosphoglycerate to glyceraldehyde 3-phosphate (2 NADPH per CO<sub>2</sub> fixed). Thus the operation of the cycle consumes 3 ATP and 2 NADPH per CO<sub>2</sub> fixed. (See Fig. 20-14, p. 762.)

**9) Page: 767**

Describe the reaction sequence by which 2-phosphoglycolate (produced when O<sub>2</sub> replaces CO<sub>2</sub> as substrate for rubisco) is converted to serine. Name each enzyme and any cofactors required and indicate the subcellular compartment in which the reaction takes place.

**Ans:** 2-phosphoglycolate is converted to glycolate by a phosphatase in the chloroplast. Glycolate is transported to the peroxisome and converted to glyoxylate by glycolate oxidase. The glyoxylate is then converted in the peroxisome to glycine by a transaminase that requires pyridoxal phosphate. Finally, two molecules of glycine are converted to serine + NH<sub>3</sub> + CO<sub>2</sub> by the enzyme glycine decarboxylase, which is located in the mitochondrion.

**10) Page: 764**

How does glyceraldehyde 3-phosphate formed in the chloroplast stroma by the Calvin cycle reactions enter the cytosol?

**Ans:** It is converted to dihydroxyacetone phosphate or to 3-phosphoglycerate and carried into the cytosol by the P<sub>i</sub>-triose phosphate antiporter, a specific transporter in the inner chloroplast membrane. (See Fig. 20-16, p. 764.)

**11) Pages: 771-772**

Explain the utility to plants in using sucrose as the transport form of carbon.

**Ans:** Sucrose is a nonreducing disaccharide, with its glycosidic linkage between the anomeric carbons of glucose and fructose. The unavailability of these normally reactive carbons prevents sucrose from reacting nonenzymatically with amino acids or proteins, and this unusual bond is not hydrolyzed by amylases or other common carbohydrate-cleaving enzymes.

**12) Pages: 766-768**

Describe the oxygenase activity of ribulose 1,5-bisphosphate carboxylase/oxygenase (rubisco) and explain why this reaction is undesirable from the point of view of a plant.

**Ans:** The condensation of molecular oxygen with ribulose 1,5-bisphosphate yields 3-phosphoglycerate and the two-carbon compound phosphoglycolate. Phosphoglycolate has no known metabolic role; its carbon is salvaged by a series of reactions that consume  $O_2$  and produce  $CO_2$  – the “photorespiration” process. The salvage pathway requires energy, and therefore the oxygenase reaction of rubisco represents a net energy cost to the plant cell in which it occurs.

## Chapter 23

**1) Page: 887 Ans: D**

Insulin is an example of a(n) \_\_\_\_\_ hormone.

- A) catecholamine
- B) eicosanoid
- C) paracrine
- D) peptide**
- E) steroid

**2) Pages: 893-896 Ans: E**

Which of the following statements about metabolism in the mammalian liver is *false*?

- A) Most plasma lipoproteins are synthesized in the liver.
- B) The enzymatic complement of liver tissue changes in response to changes in the diet.
- C) The liver synthesizes most of the urea produced in the body.
- D) The presence of glucose 6-phosphatase makes liver uniquely able to release glucose into the bloodstream.
- E) Under certain conditions, most of the functions of the liver can be performed by other organs.**

**3) Page: 898 Ans: B**

In skeletal muscle:

- A) amino acids are an essential fuel.
- B) at rest, fatty acids are the preferred fuel.**
- C) large quantities of triacylglycerol are stored as fuel.
- D) phosphocreatine can substitute for ATP as the direct source of energy for muscle contraction.
- E) stored muscle glycogen can be converted to glucose and released to replenish blood glucose.

**4) Page: 900 Ans: A**

Which one of the following statements is true?

- A) The brain prefers glucose as an energy source, but can use ketone bodies.**
- B) Muscle cannot use fatty acids as an energy source.
- C) In a well-fed human, about equal amounts of energy are stored as glycogen and as triacylglycerol.
- D) Fatty acids cannot be used as an energy source in humans because humans lack the enzymes of the glyoxylate cycle.
- E) Amino acids are a preferable energy source over fatty acids.

**5) Page: 902 Ans: D**

When blood glucose is abnormally high, the pancreas releases:

- A) epinephrine.
- B) glucagon.
- C) glucose.
- D) insulin.**
- E) trypsin.

**6) Page: 895**

Describe five possible fates for glucose 6-phosphate in the liver.

**Ans:** Possible answers include: (1) conversion to liver glycogen; (2) dephosphorylation and release of glucose into bloodstream; (3) oxidation via the pentose phosphate pathway; (4) oxidation via glycolysis and the citric acid cycle; (5) oxidation to acetyl-CoA, which then serves as precursor for synthesis of triacylglycerols, phospholipids, and cholesterol. (See Fig. 23-13, p. 895.)