

LEC 5 Q- METABOLISIM

1. Which of the following best describes the overall energy yield of the TCA cycle per molecule of Acetyl-CoA?

- A) 2 ATP
- B) 10 ATP equivalents
- C) 15 ATP
- D) 5 ATP

Answer: B

2. What is the primary purpose of the TCA cycle in cellular metabolism?

- A) Lipid synthesis
- B) ATP production
- C) DNA replication
- D) Protein synthesis

Answer: B

3. Which reaction in the TCA cycle is irreversible and has a significant negative ΔG , making it a regulatory point?

- A) Conversion of succinate to fumarate
- B) Conversion of citrate to isocitrate
- C) Oxidative decarboxylation by α -ketoglutarate dehydrogenase
- D) Hydration of fumarate to malate

Answer: C

4. What happens to the levels of OAA during fasting, and how does this affect the TCA cycle?

- A) OAA levels increase, enhancing the cycle
- B) OAA is depleted, diverting Acetyl-CoA to ketogenesis
- C) OAA is synthesized from fatty acids
- D) OAA is converted to glucose

Answer: B

5. Which enzyme in the TCA cycle is inhibited by high levels of NADH, indicating a need to balance NAD⁺ levels?

- A) Citrate synthase
- B) Isocitrate dehydrogenase
- C) α -Ketoglutarate dehydrogenase
- D) Succinate dehydrogenase

Answer: B

6. Which of the following statements accurately describes the role of ATP in the TCA cycle?

- A) ATP activates citrate synthase when energy is low.
- B) High ATP levels inhibit citrate synthase to prevent unnecessary energy production.
- C) ATP is directly produced in the TCA cycle.
- D) ATP levels have no effect on the cycle's enzymes.

Answer: B

7. Which TCA cycle intermediate is crucial for synthesizing neurotransmitters like GABA?

- A) Citrate
- B) α -Ketoglutarate
- C) Succinyl-CoA
- D) Malate

Answer: B

8. In what way does the TCA cycle contribute to amino acid metabolism?

- A) It only catabolizes amino acids.
- B) It produces all amino acids directly.
- C) Intermediates of the TCA cycle serve as precursors for amino acid synthesis.
- D) Amino acids cannot enter the TCA cycle.

Answer: C.

9. What is the consequence of high levels of acetyl-CoA during fasting?

- A) Increased TCA cycle activity
- B) Increased gluconeogenesis
- C) Increased production of ketone bodies
- D) Decreased fatty acid oxidation

Answer: C

10. Which pathway is considered anaplerotic and is essential for replenishing TCA cycle intermediates?

- A) Glycolysis
- B) Gluconeogenesis
- C) Amino acid degradation
- D) Fatty acid synthesis

Answer: C

11. Which of the following is NOT a product of one turn of the TCA cycle?

- A) 3 NADH
- B) 1 GTP
- C) 2 FADH₂
- D) 1 ATP

Answer: D

12. Which of the following statements about the TCA cycle intermediates is true?

- A) They are only used for energy production.
- B) They can be converted into glucose during gluconeogenesis.
- C) They maintain large concentrations to drive the cycle.
- D) They play roles in various biosynthetic pathways.

Answer: D

13. Which enzyme catalyzes the conversion of citrate to isocitrate?

- A) α -Ketoglutarate dehydrogenase
- B) Succinate dehydrogenase
- C) Aconitase
- D) Malate dehydrogenase

Answer: C

14. During prolonged fasting, which alternative energy source becomes significant?

- A) Glucose
- B) Ketone bodies
- C) Lactate
- D) Pyruvate

Answer: B

15. What role does malate play in the TCA cycle and gluconeogenesis?

- A) It is a substrate for ATP production.
- B) It is converted directly to glucose.
- C) It leaves the mitochondria and is oxidized to OAA.
- D) It inhibits pyruvate carboxylase.

Answer: C

16. What is the significance of the TCA cycle being described as amphibolic?

- A) It is primarily involved in energy production.
- B) It connects catabolic and anabolic pathways.
- C) It operates only under aerobic conditions.
- D) It generates heat as a byproduct.

Answer: B

17. Which of the following compounds acts as a negative regulator of pyruvate carboxylase?

- A) Acetyl-CoA
- B) NADH
- C) ATP
- D) ADP

Answer: C

18. The conversion of succinyl-CoA to succinate is coupled to the synthesis of which molecule?

- A) ATP
- B) FADH₂
- C) GTP
- D) NADH

Answer: C

19. What is the primary role of citrate in cellular metabolism?

- A) Energy production
- B) Inhibition of glycolysis
- C) Precursor for amino acids
- D) Source of OAA

Answer: B

20. Which condition would lead to an increased need for anaplerotic reactions?

- A) Excess glucose availability
- B) High energy demands during exercise
- C) Decreased protein intake
- D) Increased fat intake

Answer: B

21. What is the primary function of α -ketoglutarate in the TCA cycle?

- A) It acts as an energy carrier.
- B) It serves as a precursor for amino acid synthesis.
- C) It is a product of fatty acid oxidation.
- D) It directly produces ATP.

Answer: B

22. Which compound can inhibit aconitase, affecting the TCA cycle?

- A) Citrate
- B) Fluoroacetate
- C) NADH
- D) Succinyl-CoA

Answer: B

23. In which cellular compartment does the TCA cycle take place?

- A) Cytosol
- B) Nucleus
- C) Mitochondrial matrix
- D) Endoplasmic reticulum

Answer: C

24. Which metabolic pathway is activated by high levels of acetyl-CoA when OAA is low?

- A) Glycolysis
- B) Ketogenesis
- C) Gluconeogenesis
- D) Fatty acid synthesis

Answer: B

25. What is the role of succinyl-CoA in heme biosynthesis?

- A) It is a precursor for porphyrins.
- B) It acts as a cofactor for enzymes.
- C) It is converted directly to bilirubin.
- D) It generates energy during the reaction.

Answer: A

26. Which enzyme in the TCA cycle directly contributes to the reduction of FAD to FADH₂?

- A) Isocitrate dehydrogenase
- B) Succinate dehydrogenase

- C) Citrate synthase
- D) Malate dehydrogenase

Answer: B

27. What role does ATP play in regulating isocitrate dehydrogenase activity?

- A) It acts as an activator.
- B) It has no effect on the enzyme.
- C) It inhibits the enzyme when energy levels are high.
- D) It increases the enzyme's affinity for NAD⁺.

Answer: C

28. Which TCA cycle intermediate can be converted to aspartate?

- A) Citrate
- B) Succinyl-CoA
- C) Oxaloacetate
- D) α -Ketoglutarate

Answer: C

29. During the TCA cycle, how many CO₂ molecules are released for each Acetyl-CoA that enters?

- A) 1
- B) 2
- C) 3
- D) 4

Answer: B

30. What is the effect of high levels of ADP on the TCA cycle?

- A) It inhibits energy production.
- B) It activates key enzymes to increase ATP production.
- C) It diverts intermediates to gluconeogenesis.
- D) It decreases substrate availability.

Answer: B) It activates key enzymes to increase ATP production.

31. What is the primary regulatory mechanism of the enzyme isocitrate dehydrogenase in the TCA cycle?

- A) Feedback inhibition by ATP
- B) Competitive inhibition by NADH
- C) Allosteric activation by ADP
- D) Reversible phosphorylation

Answer: C

32. In the context of the TCA cycle, which statement about the conversion of citrate to isocitrate is correct?

- A) It is a rate-limiting step.
- B) It involves a dehydration followed by a hydration reaction.
- C) It produces ATP directly.
- D) It is catalyzed by succinate dehydrogenase.

Answer: B

33. Which of the following pathways can replenish intermediates of the TCA cycle during periods of high energy demand?

- A) Glycolysis
- B) Gluconeogenesis
- C) Amino acid catabolism
- D) Fatty acid oxidation

Answer: C

34. What is the primary role of pyruvate carboxylase in relation to the TCA cycle?

- A) It converts pyruvate to acetyl-CoA.
- B) It replenishes oxaloacetate from pyruvate.
- C) It catalyzes the conversion of pyruvate to lactate.
- D) It acts as a key regulator of glycolysis.

Answer: B

35. Which TCA cycle intermediate is critical for the synthesis of glutamate and serves as a key neurotransmitter?

- A) Citrate
- B) Succinate
- C) α -Ketoglutarate
- D) Fumarate

Answer: C

36. What is the significance of the energy yield from NADH generated in the TCA cycle compared to FADH₂?

- A) NADH yields more ATP during oxidative phosphorylation than FADH₂.
- B) FADH₂ yields more ATP than NADH due to its direct entry into the electron transport chain.
- C) Both yield the same amount of ATP.
- D) NADH cannot participate in oxidative phosphorylation.

Answer: A

37. Which of the following statements about the TCA cycle and its connection to glycolysis is true?

- A) All intermediates of the TCA cycle can be derived from glycolysis.
- B) Pyruvate can enter the TCA cycle without converting to acetyl-CoA.
- C) Oxaloacetate must be regenerated for glycolysis to continue.
- D) Citrate can inhibit phosphofructokinase-1 in glycolysis.

Answer: D

38. In patients with succinate dehydrogenase deficiency, which of the following metabolites would most likely accumulate?

- A) Citrate
- B) Fumarate
- C) Malate
- D) Acetyl-CoA

Answer: B

39. During fasting, what is the primary fate of excess acetyl-CoA when oxaloacetate levels are low?

- A) It enters the TCA cycle directly.
- B) It is converted into glucose.
- C) It is diverted to ketogenesis.
- D) It undergoes fatty acid synthesis.

Answer: C

40. The TCA cycle is often described as an "amphibolic" pathway. Which of the following best describes this characteristic?

- A) It exclusively degrades carbohydrates.
- B) It is involved in both catabolic and anabolic processes.
- C) It only produces energy without using intermediates.
- D) It functions only under anaerobic conditions.

Answer: B

41. Which of the following statements accurately describes the role of the TCA cycle in metabolic pathways?

- A) It is solely responsible for energy production.
- B) It integrates carbohydrate, fat, and protein metabolism.
- C) It is a linear pathway with no feedback mechanisms.
- D) It operates independently of oxidative phosphorylation.

Answer: B

42. What is the function of the enzyme malate dehydrogenase in the TCA cycle?

- A) It converts succinate to fumarate.
- B) It regenerates oxaloacetate from malate.
- C) It catalyzes the conversion of isocitrate to α -ketoglutarate.
- D) It phosphorylates GDP to GTP.

Answer: B

43. How does high energy charge (high ATP/ADP ratio) affect the TCA cycle?

- A) It stimulates all TCA cycle enzymes.
- B) It inhibits citrate synthase and isocitrate dehydrogenase.
- C) It has no impact on the cycle.
- D) It enhances the conversion of acetyl-CoA to ketone bodies.

Answer: B

44. Which substrate is required for the enzyme pyruvate carboxylase to function properly?

- A) Acetyl-CoA
- B) Biotin
- C) NADH
- D) ATP

Answer: B

45. In the context of the TCA cycle, what is the role of ATP-citrate lyase in liver metabolism?

- A) It synthesizes ATP from citrate.
- B) It converts citrate to acetyl-CoA and oxaloacetate.
- C) It degrades citric acid to carbon dioxide.
- D) It activates isocitrate dehydrogenase.

Answer: B

46. Which of the following intermediates is involved in the synthesis of heme and is a direct product of the TCA cycle?

- A) Succinyl-CoA
- B) Citrate
- C) Fumarate
- D) α -Ketoglutarate

Answer: A

47. During the TCA cycle, which enzyme directly links the cycle to the electrontransport chain by producing FADH₂?

- A) Isocitrate dehydrogenase
- B) Malate dehydrogenase
- C) Succinate dehydrogenase
- D) Citrate synthase

Answer: C

48. What effect does the accumulation of NADH have on the TCA cycle?

- A) It enhances the activity of dehydrogenases.
- B) It inhibits the conversion of isocitrate to α -ketoglutarate.
- C) It increases the production of ATP.
- D) It activates the TCA cycle.

Answer: B

49. Which TCA cycle intermediate can be used for gluconeogenesis but cannot be directly converted to glucose?

- A) Malate
- B) Oxaloacetate
- C) Citrate
- D) α -Ketoglutarate

Answer: A

50. In the TCA cycle, which enzyme is primarily responsible for catalyzing the reaction that produces GTP?

- A) α -Ketoglutarate dehydrogenase
- B) Succinate thiokinase
- C) Isocitrate dehydrogenase
- D) Malate dehydrogenase

Answer: B

51. Which reaction in the TCA cycle is considered physiologically irreversible due to its highly negative ΔG ?

- A) Conversion of succinyl-CoA to succinate
- B) Conversion of isocitrate to α -ketoglutarate
- C) Conversion of malate to oxaloacetate
- D) Conversion of citrate to isocitrate

Answer: B

52. What is the main consequence of a deficiency in the enzyme α -ketoglutarate dehydrogenase?

- A) Accumulation of fumarate
- B) Decreased production of NADH
- C) Increased levels of acetyl-CoA
- D) Impaired amino acid metabolism

Answer: D

53. How does ATP function as a negative regulator in the TCA cycle?

- A) It inhibits citrate synthase to reduce energy production.
- B) It promotes the conversion of succinate to fumarate.
- C) It enhances the activity of α -ketoglutarate dehydrogenase.
- D) It stimulates pyruvate carboxylase activity.

Answer: A

54. Which of the following pathways provides oxaloacetate during periods of fasting?

- A) Lipolysis
- B) Glycogenolysis
- C) Gluconeogenesis
- D) Protein catabolism

Answer: C

55. The reaction catalyzed by succinate dehydrogenase directly contributes to which process?

- A) Production of NADH
- B) Generation of GTP
- C) Reduction of FAD to FADH₂
- D) Hydrolysis of succinyl-CoA

Answer: C

56. In the context of metabolic regulation, what is the effect of high NADH levels in the TCA cycle?

- A) It stimulates the conversion of malate to oxaloacetate.
- B) It indicates a low-energy state in the cell.
- C) It inhibits key dehydrogenases in the cycle.
- D) It promotes the synthesis of fatty acids.

Answer: C

57. What is the fate of excess acetyl-CoA during starvation if oxaloacetate levels are low?

- A) It is converted to pyruvate.
- B) It is used in gluconeogenesis.
- C) It is directed toward ketogenesis.
- D) It is metabolized in the TCA cycle.

Answer: C

58. Which intermediate of the TCA cycle is critical for the synthesis of neurotransmitters such as GABA?

- A) Citrate
- B) α -Ketoglutarate
- C) Succinyl-CoA
- D) Malate

Answer: B

59. What is the primary role of anaplerotic reactions in the TCA cycle?

- A) To degrade metabolic intermediates
- B) To replenish TCA cycle intermediates
- C) To produce ATP directly
- D) To facilitate fatty acid synthesis

Answer: B

60. The TCA cycle is considered amphibolic because it:

- A) Only generates energy.
- B) Involves both degradation and biosynthesis of metabolites.
- C) Functions independently of cellular respiration.
- D) Is solely responsible for fatty acid metabolism.

Answer: B

61. Which of the following statements about the reaction converting succinyl-CoA to succinate is correct?

- A) It generates NADH.
- B) It is coupled with ATP synthesis.
- C) It requires FAD as a cofactor.
- D) It releases CO₂.

Answer: B

62. The conversion of pyruvate to acetyl-CoA is irreversible due to the activity of which enzyme?

- A) Pyruvate carboxylase
- B) Pyruvate dehydrogenase complex
- C) Citrate synthase
- D) Lactate dehydrogenase

Answer: B

63. Which TCA cycle enzyme is directly inhibited by high levels of NADH, thus affecting its activity?

- A) Malate dehydrogenase
- B) Isocitrate dehydrogenase
- C) α -Ketoglutarate dehydrogenase
- D) Succinate dehydrogenase

Answer: C

64. In the context of the TCA cycle, which metabolite is a precursor for gluconeogenesis and cannot be converted back to glucose without first being reduced to malate?

- A) α -Ketoglutarate
- B) Oxaloacetate
- C) Succinyl-CoA
- D) Fumarate

Answer: B

65. What is the main reason that fatty acids cannot be converted into glucose?

- A) They do not enter the TCA cycle.
- B) They are converted to acetyl-CoA, which cannot enter gluconeogenesis.
- C) Fatty acids produce too much ATP.
- D) They do not provide energy during fasting.

Answer: B

66. Which of the following statements about the TCA cycle intermediates is true?

- A) All intermediates can be generated from glycolysis.
- B) Intermediates can act as precursors for amino acid synthesis.
- C) The TCA cycle generates glucose directly.
- D) The cycle operates only under aerobic conditions.

Answer: B

67. What metabolic pathway occurs when oxaloacetate levels are insufficient during prolonged fasting?

- A) Lipolysis
- B) Ketogenesis
- C) Glycogenolysis
- D) Lactate fermentation

Answer: B

68. How does the regulation of citrate synthase reflect the energy status of the cell?

- A) It is activated by high ATP levels.
- B) It is inhibited by NADH.
- C) It is inhibited by citrate itself.
- D) It is activated by ADP.

Answer: C

69. What is the effect of increasing levels of succinyl-CoA on the TCA cycle?

- A) It stimulates the synthesis of GTP.
- B) It inhibits the activity of citrate synthase.
- C) It enhances fatty acid synthesis.
- D) It activates pyruvate carboxylase.

Answer: B

70. Which TCA cycle intermediate is primarily involved in the synthesis of neurotransmitters and nitrogen-containing compounds?

- A) Succinyl-CoA
- B) α -Ketoglutarate
- C) Citrate
- D) Malate

Answer: B

71. What is the primary metabolic fate of pyruvate during anaerobic conditions in human cells?

- A) Conversion to acetyl-CoA
- B) Conversion to lactate
- C) Entry into the TCA cycle
- D) Conversion to malate

Answer: B) Conversion to lactate

72. In the TCA cycle, which enzyme catalyzes the reaction that is both a decarboxylation and an oxidation?

- A) Isocitrate dehydrogenase
- B) α -Ketoglutarate dehydrogenase
- C) Succinate dehydrogenase
- D) Citrate synthase

Answer: A

73. Which condition would most likely lead to an increase in ketone body production?

- A) High carbohydrate intake
- B) Prolonged fasting
- C) Increased aerobic exercise
- D) Enhanced glycolysis

Answer: B

74. During which step of the TCA cycle is carbon dioxide released?

- A) Conversion of citrate to isocitrate
- B) Conversion of isocitrate to α -ketoglutarate
- C) Conversion of succinate to fumarate
- D) Conversion of malate to oxaloacetate

Answer: B

75. The activity of which enzyme would be directly inhibited by high levels of ATP and NADH, indicating an abundant energy state?

- A) Succinate thiokinase
- B) Isocitrate dehydrogenase
- C) α -Ketoglutarate dehydrogenase
- D) Malate dehydrogenase

Answer: C

76. Which TCA cycle intermediate can be converted into fatty acids?

- A) Citrate
- B) Succinyl-CoA
- C) Fumarate
- D) α -Ketoglutarate

Answer: A

77. In the TCA cycle, which intermediate is involved in the synthesis of heme groups in erythrocytes?

- A) Citrate
- B) Succinyl-CoA
- C) Fumarate
- D) Oxaloacetate

Answer: B

78. How does an increase in malonyl-CoA affect fatty acid oxidation?

- A) It stimulates fatty acid oxidation.
- B) It inhibits fatty acid oxidation.
- C) It has no effect on fatty acid metabolism.
- D) It enhances TCA cycle activity.

Answer: B

79. What is the role of the enzyme pyruvate carboxylase in the context of the TCA cycle?

- A) Converts pyruvate to acetyl-CoA
- B) Generates oxaloacetate for the TCA cycle
- C) Converts malate to oxaloacetate
- D) Produces NADH from pyruvate

Answer: B

80. Which of the following compounds serves as an allosteric activator for pyruvate carboxylase?

- A) Acetyl-CoA
- B) Citrate
- C) ADP
- D) NADH

Answer: A

Case 1: A 30-year-old male begins a fasting regimen for weight loss. After several days, he notices increased fatigue and reduced energy levels.

Which of the following metabolic changes is likely occurring in his body during this fasting state?

- A) Increased conversion of acetyl-CoA to glucose
- B) Decreased availability of oxaloacetate for the TCA cycle
- C) Increased glycolysis for energy production
- D) Enhanced fatty acid oxidation without ketogenesis

Answer: B

Case 2: A 40-year-old individual on a ketogenic diet presents with elevated blood ketone levels and a fruity odor on their breath.

What physiological change is primarily responsible for the increased ketone body production?

- A) Increased availability of oxaloacetate
- B) Excess acetyl-CoA due to limited carbohydrate intake
- C) Enhanced TCA cycle activity
- D) Decreased fatty acid oxidation

Answer: B

A 35-year-old woman adopts a very low-carbohydrate, high-fat diet. After several weeks, she reports experiencing increased energy levels but also mild confusion.

Questions:

1. What is the primary metabolic adaptation occurring in her body due to the diet?
A) Increased glycolysis
B) Increased lipolysis and ketogenesis
C) Decreased fatty acid oxidation
D) Enhanced gluconeogenesis from carbohydrates

Answer: B

2. Which intermediate of the TCA cycle is crucial for her energy production during this dietary change?
A) Citrate
B) Oxaloacetate
C) Succinyl-CoA
D) α -Ketoglutarate

Answer: B

A 28-year-old male athlete supplements with high doses of glucagon before a competition.

Questions:

1. What metabolic effect does glucagon primarily exert in this scenario? A)
Increased glycolysis
B) Decreased lipolysis
C) Enhanced gluconeogenesis
D) Decreased amino acid breakdown

Answer: C

2. How would this hormone affect the availability of TCA cycle intermediates?
A) It would increase oxaloacetate levels.
B) It would decrease the conversion of acetyl-CoA to citrate.
C) It would enhance the conversion of succinyl-CoA to succinate.
D) It would have no effect on TCA intermediates.

Answer: A

A patient is diagnosed with a deficiency in the enzyme isocitrate dehydrogenase.

Questions:

1. What would be a likely biochemical consequence of this deficiency?
A) Accumulation of citrate and reduced NADH production
B) Increased levels of α -ketoglutarate
C) Enhanced conversion of succinate to fumarate
D) Decreased production of ATP

Answer: A

2. How might this deficiency affect the overall energy metabolism in the patient?
A) It would enhance the TCA cycle's efficiency.
B) It would lead to increased reliance on anaerobic metabolism.
C) It would result in excessive gluconeogenesis.
D) It would promote increased fatty acid synthesis.

Answer: B

A 50-year-old male presents with fatigue and muscle weakness. Lab results indicate elevated levels of acetyl-CoA and decreased levels of oxaloacetate.

Questions:

1. What metabolic consequence is most likely occurring in this patient?
 - A) Decreased fatty acid oxidation
 - B) Increased production of ketone bodies
 - C) Enhanced gluconeogenesis
 - D) Increased glycolysis

Answer: B

2. How does the low level of oxaloacetate impact the TCA cycle?
 - A) It stimulates citrate synthesis.
 - B) It inhibits the conversion of succinyl-CoA to succinate.
 - C) It prevents the proper functioning of the TCA cycle.
 - D) It enhances NADH production.

Answer: C

Done By : Khaled Ghanayem