

LEC 9 Q – METABOLISIM

- 1. What is the primary role of NADH in oxidative phosphorylation?**
 - A) Acts as a final electron acceptor
 - B) Provides electrons to the electron transport chain
 - C) Synthesizes ATP directly
 - D) Regulates oxygen consumption
- 2. Which complex in the electron transport chain is responsible for reducing O_2 to H_2O ?**
 - A) Complex I
 - B) Complex II
 - C) Complex III
 - D) Complex IV
- 3. What is the main regulator of ATP production during oxidative phosphorylation?**
 - A) NADH
 - B) ADP
 - C) Pi (Inorganic Phosphate)
 - D) O_2
- 4. How does oligomycin affect ATP production?**
 - A) It enhances proton flow through ATP synthase
 - B) It inhibits the electron transport chain
 - C) It prevents the influx of H^+ through ATP synthase
 - D) It increases oxygen consumption
- 5. What is the function of uncoupling proteins (UCPs) in metabolism?**
 - A) Increase ATP synthesis
 - B) Allow protons to bypass ATP synthase, generating heat
 - C) Facilitate electron transfer in the ETC
 - D) Act as inhibitors of the Krebs cycle
- 6. Which type of adipose tissue is primarily involved in non-shivering thermogenesis?**
 - A) White adipose tissue
 - B) Brown adipose tissue
 - C) Subcutaneous adipose tissue
 - D) Visceral adipose tissue
- 7. What are the consequences of using chemical uncouplers like 2,4-dinitrophenol (DNP)?**

- A) Increased ATP production and energy storage
 - B) Disruption of the coupling between electron transport and phosphorylation
 - C) Decreased oxygen consumption
 - D) Enhanced synthesis of mitochondrial proteins
8. **How is mitochondrial DNA inherited?**
- A) Paternally
 - B) Maternally
 - C) Autosomally
 - D) From both parents equally
9. **What characterizes the mutation rate of mitochondrial DNA compared to nuclear DNA?**
- A) It is lower
 - B) It is higher
 - C) It is the same
 - D) It varies greatly with age
10. **Which disease is associated with mutations in mitochondrial DNA affecting vision?**
- A) Neuropathy, Ataxia, and Retinitis Pigmentosa
 - B) Familial Infantile Bilateral Striatal Necrosis
 - C) Leber's Hereditary Optic Neuropathy
 - D) Mitochondrial Myopathy

Answers

- 1. B
- 2. D
- 3. B
- 4. C
- 5. B
- 6. B
- 7. B
- 8. B
- 9. B
- 10. C

11. **What is the primary function of cytochrome C in the electron transport chain?**
- A) Acts as a mobile electron carrier
 - B) Catalyzes the reduction of O₂
 - C) Inhibits ATP synthase
 - D) Extracts electrons from NADH

12. **Which process occurs simultaneously with the electron transport chain to ensure efficient ATP production?**
- A) Glycolysis
 - B) Krebs cycle
 - C) Oxidative phosphorylation
 - D) Fermentation
13. **What happens to ATP synthesis if ADP levels are low?**
- A) ATP production increases
 - B) ATP production decreases
 - C) Oxygen consumption decreases
 - D) Krebs cycle accelerates
14. **Which of the following is NOT a specific inhibitor of the electron transport chain?**
- A) Antimycin A
 - B) Oligomycin
 - C) Rotenone
 - D) UCP1
15. **What is the main characteristic of brown adipose tissue compared to white adipose tissue?**
- A) Higher lipid content
 - B) Lower mitochondrial density
 - C) Greater capacity for thermogenesis
 - D) Primarily involved in energy storage
16. **What do uncoupling proteins help regulate in the body?**
- A) Blood glucose levels
 - B) Body temperature through heat generation
 - C) Oxygen uptake during exercise
 - D) Muscle contraction efficiency
17. **Which genetic pattern is typical for nuclear genetic disorders affecting oxidative phosphorylation?**
- A) X-linked dominance
 - B) Autosomal recessive inheritance
 - C) Mitochondrial inheritance
 - D) Codominance
18. **What are the primary tissues affected by mitochondrial DNA mutations due to their high ATP demands?**

- A) Skin and hair follicles
- B) Adipose tissue and cartilage
- C) Central nervous system, heart, and skeletal muscle
- D) Liver and pancreas

19. How does the presence of UCPs impact energy metabolism?

- A) They enhance ATP synthesis
- B) They increase the risk of obesity
- C) They allow for energy dissipation as heat
- D) They inhibit the electron transport chain

20. What is the typical inheritance pattern for mutations in mitochondrial DNA?

- A) Autosomal dominant
- B) Paternal inheritance
- C) Maternal inheritance only
- D) Sporadic mutations

Answers

- 11. A
- 12. C
- 13. B
- 14. D
- 15. C
- 16. B
- 17. B
- 18. C
- 19. C
- 20. C

21. Which statement best describes the process of respiratory control in oxidative phosphorylation?

- A) It is independent of ADP concentrations.
- B) It is solely dependent on the availability of O₂.
- C) It relates to the relationship between ADP levels and ATP synthesis rates.
- D) It is influenced by the concentrations of NADH and FADH₂ only.

22. What role does mitochondrial DNA play in the coding of electron transport chain proteins?

- A) It encodes all proteins required for the Krebs cycle.
- B) It encodes a limited number of proteins and requires nuclear DNA for the rest.
- C) It is responsible for the synthesis of all mitochondrial enzymes.
- D) It only provides tRNA necessary for protein synthesis.

23. **What distinguishes UCP1 from other uncoupling proteins like UCP2 and UCP3?**
- A) UCP1 is found in skeletal muscle, while others are in adipose tissue.
 - B) UCP1 is highly expressed in brown adipose tissue and is directly activated by fatty acids.
 - C) UCP1 is involved in ATP synthesis, whereas UCP2 and UCP3 are not.
 - D) UCP1 is primarily a thermoregulatory protein, unlike the others.
24. **What is the consequence of increased mitochondrial heteroplasmy in cells?**
- A) Enhanced efficiency in ATP production
 - B) Increased susceptibility to oxidative damage
 - C) Greater variability in the expression of mitochondrial diseases
 - D) Decreased metabolic flexibility
25. **How do chemical uncouplers like DNP affect the overall efficiency of oxidative phosphorylation?**
- A) They increase the ATP yield from glucose metabolism.
 - B) They enhance the proton motive force leading to more ATP synthesis.
 - C) They decrease ATP production while increasing heat generation and oxygen consumption.
 - D) They solely affect the Krebs cycle without influencing the ETC.
26. **Which of the following best describes the process of replicative segregation in mitochondria?**
- A) Mitochondrial DNA is replicated evenly in each cell division.
 - B) Mitochondria are randomly distributed to daughter cells during cell division.
 - C) All mitochondria in a cell are identical before division.
 - D) Mutated mtDNA is selectively preserved in daughter cells.
27. **In terms of energy metabolism, what is the primary physiological role of non-shivering thermogenesis?**
- A) To conserve energy during periods of fasting
 - B) To produce ATP for muscle contraction
 - C) To generate heat in response to cold exposure
 - D) To enhance the storage of fat in adipose tissue
28. **What molecular mechanism allows for the activation of uncoupling proteins in response to metabolic needs?**
- A) Direct phosphorylation by kinases
 - B) Fatty acid binding that induces conformational changes
 - C) Increased levels of ADP and Pi
 - D) Changes in mitochondrial membrane potential

29. **Which of the following accurately describes the impact of mtDNA mutations with age?**
- A) They remain constant throughout life.
 - B) They accumulate somatic mutations, increasing disease risk.
 - C) They exclusively affect brain tissues.
 - D) They are only inherited from the mother.
30. **What is a key factor in the increased risk of cardiometabolic diseases associated with UCP mutations?**
- A) Elevated ATP synthesis rates
 - B) Impaired thermogenesis leading to weight gain
 - C) Increased efficiency of the electron transport chain
 - D) Enhanced production of reactive oxygen species

Answers

- 21. C
- 22. B
- 23. B
- 24. C
- 25. C
- 26. B
- 27. C
- 28. B
- 29. B
- 30. B

31. **What is the consequence of a mutation in the gene encoding a subunit of Complex I of the electron transport chain?**
- A) Increased ATP synthesis
 - B) Decreased NADH oxidation and reduced ATP production
 - C) Enhanced electron transfer to oxygen
 - D) Upregulation of uncoupling proteins
32. **In the context of mitochondrial diseases, what is the significance of heteroplasmy?**
- A) It leads to uniform expression of mtDNA mutations.
 - B) It can result in variable clinical manifestations depending on the proportion of mutated mtDNA.
 - C) It eliminates the risk of developing mitochondrial disorders.
 - D) It is only relevant for nuclear DNA mutations.
33. **How does the regulation of oxidative phosphorylation differ from other metabolic pathways?**

- A) It is solely regulated by substrate availability.
 - B) It is tightly linked to oxygen levels but primarily controlled by ADP concentrations.
 - C) It operates independently of the Krebs cycle.
 - D) It does not respond to changes in energy demand.
34. **What mechanism is primarily responsible for the development of oxidative stress in tissues with high mitochondrial mutation rates?**
- A) Decreased ATP production leading to energy depletion
 - B) Accumulation of reactive oxygen species due to inefficient electron transfer
 - C) Enhanced fatty acid oxidation
 - D) Increased heat production from uncoupling proteins
35. **Which factor contributes most significantly to the regulation of non-shivering thermogenesis in brown adipose tissue?**
- A) Availability of glucose
 - B) Direct activation of UCP1 by thyroid hormones
 - C) Presence of cold temperatures and fatty acids
 - D) Levels of insulin in the bloodstream
36. **What role does cytochrome c play in apoptosis, aside from its function in the electron transport chain?**
- A) It enhances ATP production during cell stress.
 - B) It serves as a signaling molecule for programmed cell death.
 - C) It prevents oxidative damage in mitochondria.
 - D) It acts as a cofactor for other respiratory enzymes.
37. **How does the presence of uncoupling proteins in skeletal muscle differ from their presence in brown adipose tissue?**
- A) UCPs in skeletal muscle primarily promote ATP synthesis.
 - B) UCPs in skeletal muscle are mainly involved in thermogenesis.
 - C) UCPs in skeletal muscle do not impact energy expenditure.
 - D) UCPs in skeletal muscle have a lower expression level than in brown adipose tissue.
38. **What is the primary effect of the inhibition of Complex IV by substances such as cyanide?**
- A) Increased ATP synthesis
 - B) Accumulation of electrons leading to reactive oxygen species formation
 - C) Enhanced proton motive force
 - D) Decreased ADP phosphorylation
39. **Why is the mutation rate of mitochondrial DNA significantly higher than that of nuclear DNA?**

- A) Mitochondrial DNA undergoes more replication cycles.
- B) Mitochondrial DNA lacks repair mechanisms found in nuclear DNA.
- C) Nuclear DNA is more stable due to its structure.
- D) Mitochondrial DNA is less exposed to oxidative damage.

40. **What potential therapeutic approach is being investigated to mitigate the effects of oxidative phosphorylation diseases?**

- A) Directly enhancing ATP production through synthetic pathways
- B) Increasing the activity and quantity of brown adipose tissue to promote energy dissipation
- C) Suppressing the expression of mitochondrial DNA
- D) Administering inhibitors of the electron transport chain

Answers

- 31. B
- 32. B
- 33. B
- 34. B
- 35. C
- 36. B
- 37. D
- 38. B
- 39. B
- 40. B

41. **Which of the following best describes the role of ATP synthase in oxidative phosphorylation?**

- A) It catalyzes the reduction of oxygen to water.
- B) It uses the proton gradient to synthesize ATP from ADP and Pi.
- C) It transports electrons across the mitochondrial membrane.
- D) It regulates the activity of the electron transport chain.

42. **What is the impact of oligomycin on mitochondrial function?**

- A) It enhances ATP production by increasing proton flow.
- B) It inhibits ATP synthase, leading to a decrease in ATP production and an increase in the proton gradient.
- C) It increases electron flow through the ETC.
- D) It acts as an uncoupling agent, promoting heat generation.

43. **Which of the following mechanisms best explains the concept of “acceptor control” in mitochondrial respiration?**

- A) Regulation of the electron transport chain by NADH levels.
- B) Regulation of ATP production by the availability of O₂.
- C) Regulation of ATP synthesis by ADP concentration.
- D) Regulation of proton leakage across the inner mitochondrial membrane.

44. **Which type of UCP is primarily involved in thermogenesis in infants?**
- A) UCP2
 - B) UCP3
 - C) UCP1
 - D) UCP4
45. **How do mutations in UCP genes potentially influence body weight?**
- A) By increasing the efficiency of ATP production.
 - B) By promoting energy dissipation as heat instead of storage as fat.
 - C) By enhancing glucose uptake in adipose tissue.
 - D) By decreasing metabolic rate and energy expenditure.
46. **What role does mitochondrial DNA play in the inheritance of oxidative phosphorylation disorders?**
- A) It is inherited from both parents in equal proportions.
 - B) It is inherited maternally, leading to unique patterns of disease expression.
 - C) It shows random mutations that do not affect inheritance.
 - D) It can only be inherited if the nuclear DNA is also mutated.
47. **Which condition is characterized by a specific mtDNA mutation leading to optic nerve dysfunction?**
- A) Leigh syndrome
 - B) Leber's Hereditary Optic Neuropathy
 - C) Mitochondrial Myopathy
 - D) Kearns-Sayre Syndrome
48. **What is the primary role of the Krebs cycle in relation to oxidative phosphorylation?**
- A) It generates ATP directly through substrate-level phosphorylation.
 - B) It produces NADH and FADH₂, which serve as electron donors for the ETC.
 - C) It acts independently of mitochondrial respiration.
 - D) It detoxifies reactive oxygen species produced during metabolism.
49. **Which of the following statements about brown adipose tissue is true?**
- A) It primarily stores energy as triglycerides.
 - B) It is less vascularized than white adipose tissue.
 - C) It contains a higher number of mitochondria than white adipose tissue.
 - D) It lacks uncoupling proteins.
50. **In the context of energy metabolism, how does increased ADP concentration affect mitochondrial function?**

- A) It inhibits the Krebs cycle.
- B) It stimulates ATP synthesis and increases oxygen consumption.
- C) It leads to decreased electron flow through the ETC.
- D) It reduces the activity of uncoupling proteins.

Answers

- 41. B
- 42. B
- 43. C
- 44. C
- 45. B
- 46. B
- 47. B
- 48. B
- 49. C
- 50. B

51. What is the primary consequence of inhibiting Complex III of the electron transport chain?

- A) Increased ATP production due to enhanced proton flow
- B) Decreased electron transfer and increased production of reactive oxygen species
- C) Enhanced reduction of oxygen to water
- D) Increased oxidation of NADH without affecting ATP levels

52. What is the main function of the proton motive force in oxidative phosphorylation?

- A) To synthesize glucose during gluconeogenesis
- B) To drive ATP synthesis by facilitating proton flow through ATP synthase
- C) To transport electrons between the complexes of the ETC
- D) To regulate the entry of ADP into the mitochondria

53. How do mutations in mtDNA genes related to mitochondrial function manifest in patients?

- A) They only affect skeletal muscle.
- B) They typically show autosomal dominant inheritance patterns.
- C) They can affect any tissue but have a more pronounced effect on high-energy-demand tissues.
- D) They lead to exclusive symptoms related to mitochondrial myopathy.

54. What triggers the activation of uncoupling proteins (UCPs) in brown adipose tissue?

- A) Increased availability of glucose
- B) Cold exposure and increased levels of free fatty acids

- C) High levels of insulin
- D) Elevated ATP concentrations

55. What is the primary effect of non-shivering thermogenesis in infants?

- A) To promote fat storage in adipose tissue
- B) To regulate blood sugar levels
- C) To generate heat and maintain body temperature
- D) To enhance muscle growth

56. What distinguishes UCP3 from UCP1 in terms of tissue distribution and function?

- A) UCP3 is primarily found in brown adipose tissue, while UCP1 is in skeletal muscle.
- B) UCP3 is involved in regulating ATP synthesis, while UCP1 is not.
- C) UCP3 is found in skeletal muscle and is less involved in thermogenesis compared to UCP1.
- D) UCP3 has a higher expression level in brown adipose tissue than UCP1.

57. In the context of mitochondrial diseases, what is a common feature of mtDNA mutations?

- A) They are always inherited in an autosomal dominant manner.
- B) They typically lead to immediate onset of symptoms at birth.
- C) They can exhibit variable expressivity due to heteroplasmy.
- D) They do not affect energy metabolism.

58. Which of the following best describes the effect of high levels of reactive oxygen species (ROS) in mitochondria?

- A) They enhance ATP production and cellular signaling.
- B) They can damage mitochondrial DNA and proteins, leading to dysfunction.
- C) They promote efficient electron transfer in the ETC.
- D) They have no significant impact on mitochondrial function.

59. What metabolic pathway is primarily affected when cyanide inhibits Complex IV?

- A) Glycolysis
- B) Krebs cycle
- C) Oxidative phosphorylation
- D) Fatty acid oxidation

60. Which statement regarding the genetic inheritance of mitochondrial disorders is true?

- A) Both parents contribute equally to the mitochondrial genome.
- B) Only maternal inheritance is observed due to the structure of mitochondria.

- C) Mitochondrial disorders are exclusively linked to nuclear DNA mutations.
D) Mitochondrial disorders follow an X-linked pattern of inheritance.

Answers

51. B
52. B
53. C
54. B
55. C
56. C
57. C
58. B
59. C
60. B

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