LEC 6 Q- CYTOLOGY :

1. **What is the primary function of mitochondria in eukaryotic cells?**

   A) Protein synthesis

   B) Lipid metabolism

   C) ATP generation from carbohydrates and fatty acids

   D) DNA replication

   Answer: C

2. **Which of the following is a key piece of evidence supporting the endosymbiotic theory of mitochondria?**

   A) Presence of ribosomes

   B) Double-membrane structure

   C) Circular mitochondrial DNA (mtDNA)

   D) Both B and C

   Answer: D

3. **Which statement about mitochondrial DNA (mtDNA) is true?**

   A) It is inherited from both parents.

   B) It is linear in structure.

   C) It encodes for 13 mitochondrial proteins.

   D) It is found in the nucleus.

   Answer: C

4. **Mitochondrial diseases are most likely to affect which type of tissues?**

   A) Connective tissues

   B) Muscle and nervous tissues

   C) Epithelial tissues

   D) Blood tissues

   Answer: B

5. **Which of the following mitochondrial diseases is characterized by defects in the respiratory chain and often leads to optic nerve degeneration?**

    A) MELAS

    B) LHON

    C) MERRF

    D) NARP

    Answer: B

6. **What is a key function of peroxisomes in the cell?**

    A) Synthesis of ribosomal RNA

    B) Breakdown of hydrogen peroxide

    C) Storage of genetic material

    D) Production of ATP

    Answer: B

7. **Which metabolic process occurs first in peroxisomes before proceeding to mitochondria?**

    A) Glucose metabolism

    B) Fatty acid oxidation

    C) Protein synthesis

    D) Cholesterol synthesis

    Answer: B

8. **What condition is associated with defective transport of very long-chain fatty acids in peroxisomes?**

    A) Zellweger syndrome

    B) X-linked Adrenoleukodystrophy (XALD)

    C) MERRF

    D) LHON

    Answer: B

9. **Which of the following statements about peroxisomes is true?**

A) They are exclusively involved in lipid synthesis.

B) They replicate by fission and fusion.

C) They contain only lysosomal enzymes.

D) They are larger than mitochondria.

Answer: B

10. **Peroxins are best described as:**

A) Enzymes involved in mitochondrial function.

B) Proteins that facilitate the import of peroxisomal enzymes.

C) Mitochondrial DNA-binding proteins.

D) Components of the electron transport chain.

Answer: B

11. **Which of the following mitochondrial functions is most directly associated with the formation of cristae in the inner membrane?**

A) ATP synthesis efficiency

B) Transport of metabolites

C) mtDNA replication

D) Regulation of apoptosis

Answer: A

12. **What is the significance of the TOM and TIM complexes in mitochondrial protein import?**

A) They facilitate ATP synthesis.

B) They are involved in the import of proteins synthesized in the mitochondria.

C) They regulate mitochondrial fusion and fission.

D) They allow for the translocation of nuclear-encoded proteins into mitochondria.

Answer: D

13. **Mitochondrial diseases associated with defects in mtDNA are typically inherited in what manner?**

    A) Autosomal dominant

    B) Autosomal recessive

    C) Maternal inheritance

    D) X-linked inheritance

Answer: C

14. **What impact does aging have on mitochondrial function?**

    A) It enhances ATP production.

    B) It decreases the mutation rate in mtDNA.

    C) It increases the likelihood of mtDNA mutations.

    D) It improves the efficiency of oxidative phosphorylation.

Answer: C

15. **In the context of mitochondrial diseases, which of the following is a potential consequence of Pyruvate Dehydrogenase (PDH) deficiency?**

    A) Decreased lactate levels in the blood

    B) Enhanced conversion of Acetyl-CoA to pyruvate

    C) Increased reliance on anaerobic metabolism

    D) Normal Krebs cycle function

Answer: C

16. **Which of the following best describes the composition of peroxisomal membranes compared to mitochondrial membranes?**

    A) Peroxisomal membranes contain a higher percentage of proteins.

    B) Mitochondrial membranes are impermeable to all ions.

    C) Peroxisomal membranes are similar to lysosomal membranes in lipid composition.

D) Mitochondrial membranes contain more phospholipids than peroxisomal membranes.

Answer: A

17. **What is the primary metabolic consequence of a deficiency in peroxisomal fatty acid oxidation?**

A) Decreased ATP production

B) Increased levels of uric acid

C) Accumulation of very long-chain fatty acids (VLCFAs)

D) Enhanced cholesterol synthesis

Answer: C

18. **In the context of peroxisomal diseases, what is the role of PEX genes?**

A) They encode enzymes for the Krebs cycle.

B) They are involved in mitochondrial DNA replication.

C) They are essential for peroxisomal biogenesis and function.

D) They regulate mitochondrial membrane permeability.

Answer: C

19. **Which of the following statements about the import of peroxisomal proteins is accurate?**

A) All peroxisomal proteins are synthesized in the mitochondria.

B) Proteins with PTS1 targeting signals are recognized by specific receptors on peroxisomal membranes.

C) All peroxisomal proteins require ATP for import.

D) Membrane proteins are exclusively imported from the cytosol.

Answer: B

20. **What unique feature distinguishes the lipid cardiolipin in mitochondria, and why is it important?**

A) It is exclusively synthesized in the ER.

B) It enhances the activity of electron transport chain complexes.

C) It is a key component of peroxisomal membranes.

D) It is responsible for mitochondrial division.

Answer: B

21. **Given the dual origins of mitochondrial DNA, which aspect of mitochondria suggests their evolutionary history involves a symbiotic relationship with prokaryotes?**

A) Their ability to replicate independently

B) The presence of a double-membrane structure

C) Their role in oxidative phosphorylation

D) The circular form of mitochondrial DNA

Answer: D

22. **When considering the distribution of mitochondrial proteins, which statement might lead you to infer the significance of nuclear DNA in mitochondrial function?**

A) Most mitochondrial proteins are synthesized in the mitochondria.

B) The majority of mitochondrial proteins are encoded by nuclear DNA.

C) mtDNA only encodes for a few tRNAs.

D) Mitochondria lack their own ribosomes.

Answer: B

23. **In analyzing the consequences of mitochondrial mutations with aging, which implication might be drawn regarding cellular energy efficiency?**

A) Aging leads to increased ATP production.

B) The effectiveness of oxidative phosphorylation diminishes.

C) Mitochondrial fusion increases.

D) The mutation rate in nuclear DNA decreases.

Answer: B

24. **Reflecting on the genetic inheritance of certain mitochondrial disorders, how might one explain the observed patterns of transmission in affected families?**

A) They follow classical Mendelian inheritance.

B) They exhibit maternal inheritance patterns.

C) They are exclusively inherited from the father.

D) They show a dominant inheritance pattern.

Answer: B

25. **Considering the unique role of the inner mitochondrial membrane in energy production, which feature could you identify as essential for maximizing its efficiency?**

A) The presence of porins

B) The formation of cristae

C) The impermeability to most ions

D) The synthesis of ATP outside the membrane

Answer: B

26. **If one were to examine the metabolic pathways involving fatty acids, which characteristic of peroxisomes might highlight their critical role before these substrates enter the mitochondria?**

A) They synthesize cholesterol.

B) They primarily oxidize very long-chain fatty acids.

C) They replicate through fission.

D) They degrade uric acid.

Answer: B

27. **When assessing the impact of specific enzyme deficiencies on cellular metabolism, which condition could be inferred to lead to toxic accumulation in the absence of functional peroxisomes?**

A) Decreased synthesis of phospholipids

B) Elevated levels of hydrogen peroxide

C) Impaired β-oxidation of fatty acids

D) Enhanced ATP production

Answer: C

28. **In the context of the interplay between various organelles, what conclusion might be drawn regarding the importance of peroxisomal enzymes in cellular homeostasis?**

A) They are redundant due to mitochondrial functions.

B) They are critical for detoxifying metabolic byproducts.

C) Their functions are only relevant during cell division.

D) They solely support lipid synthesis pathways.

Answer: B

29. **If a specific mutation affects the PEX genes involved in peroxisome formation, what broader consequence might be anticipated regarding cellular metabolism?**

A) Enhanced fatty acid oxidation

B) Disruption of multiple metabolic pathways

C) Increased levels of ATP synthesis

D) Normal function of all peroxisomal enzymes

Answer: B

30. **When considering the diverse functions of organelles, how might the unique biochemical activities of peroxisomes be best characterized in relation to mitochondrial functions?**

A) They perform identical roles in energy metabolism.

B) They share similar functions but operate under different conditions.

C) They act as a backup system for mitochondrial processes.

D) They are involved in distinct metabolic pathways complementary to mitochondrial functions.

Answer: D

31. **Considering the implications of maternal inheritance of mitochondrial DNA, what potential outcome might arise in offspring when a mother carries a mix of normal and mutant mtDNA?**

    A) All offspring will express normal mitochondrial function.

    B) Offspring may exhibit variable expression of mitochondrial disorders depending on the proportion of mutant mtDNA.

    C) Sons will be more severely affected than daughters.

    D) Offspring will show no phenotypic variation.

    Answer: B

32. **In the context of energy production, what could be inferred about the necessity of mitochondrial cristae in relation to the demand for ATP in high-energy tissues?**

    A) Increased surface area of cristae reduces ATP synthesis.

    B) The cristae's structure is irrelevant to ATP generation.

    C) Greater surface area facilitates more ATP synthesis, meeting energy demands.

    D) Cristae formation occurs only in low-energy tissues.

    Answer: C

33. **Reflecting on the functional roles of mitochondria, how might one interpret the significance of the intermembrane space in relation to proton gradients during oxidative phosphorylation?**

    A) It serves solely as a storage compartment for proteins.

    B) It plays a crucial role in maintaining the electrochemical gradient necessary for ATP synthesis.

    C) It is unimportant in the overall metabolic processes of the cell.

    D) It is the primary site for the Krebs cycle.

    Answer: B

34. **If a patient exhibits symptoms of lactic acidosis, which metabolic pathway disruption might logically be implicated based on mitochondrial functions?**

A) Impaired fatty acid synthesis

B) Defective pyruvate metabolism due to PDH deficiency

C) Enhanced mitochondrial respiration

D) Normal glycolysis

Answer: B

35. **Considering the dynamic nature of mitochondria, how might the processes of fusion and fission relate to cellular stress responses?**

A) They are only involved in normal growth and development.

B) Fusion aids in the repair of damaged mitochondria, while fission may promote the elimination of dysfunctional parts.

C) They do not influence mitochondrial function.

D) Both processes lead to decreased mitochondrial efficiency.

Answer: B

36. **What might be inferred about the relationship between peroxisomal function and oxidative stress in cells?**

A) Peroxisomes contribute to increased oxidative stress due to their metabolic byproducts.

B) They play a critical role in mitigating oxidative stress through the breakdown of hydrogen peroxide.

C) Peroxisomes have no impact on oxidative stress levels.

D) Their function is primarily to produce reactive oxygen species.

Answer: B

37. **In examining the genetic basis of peroxisomal disorders, how might mutations in peroxin genes affect overall cellular metabolism?**

A) They only affect fatty acid metabolism.

B) They can lead to widespread metabolic dysfunction due to multiple enzyme deficiencies.

C) They will enhance cellular metabolism.

D) They have no impact on metabolic processes outside peroxisomes.

Answer: B

38. **When considering the assembly and maturation of peroxisomes, what conclusion can be drawn about the significance of PTS1 targeting signals?**

A) They are irrelevant for protein import into peroxisomes.

B) They are critical for directing proteins to their correct organelle.

C) All peroxisomal proteins utilize PTS1 for import.

D) They only function during peroxisome division.

Answer: B

39. **In the context of energy metabolism, what underlying principle connects peroxisomes and mitochondria regarding fatty acid processing?**

A) Both organelles synthesize fatty acids exclusively.

B) Fatty acids are first oxidized in peroxisomes before entering mitochondria for further oxidation.

C) Peroxisomes do not interact with fatty acids.

D) Mitochondria solely handle fatty acid oxidation without peroxisomal involvement.

Answer: B

40. **Given the role of peroxisomes in breaking down very long-chain fatty acids, what implications might their dysfunction have on neurological health?**

A) It would enhance neuronal function due to increased fatty acid availability.

B) Dysfunction could lead to the accumulation of toxic metabolites affecting neuronal health.

C) There would be no effect on neurological health.

D) It would solely impact muscle function.

Answer: B

A 5-year-old boy is brought to the clinic with progressive muscle weakness, exercise intolerance, and episodes of lactic acidosis. Genetic testing reveals a mutation in mitochondrial DNA. Which of the following statements best describes the implications of this condition?

1. The child is likely to inherit this condition from his father.
2. Muscle tissues are particularly vulnerable due to their high ATP demand.
3. Treatment options include solely dietary modifications to manage symptoms.
4. The child may experience variable expression of symptoms due to heteroplasmy.

Select all that apply.

A) 1 and 2

B) 2 and 4

C) 3 only

D) 2 and 3

Answer: B

A 30-year-old woman presents with neurological symptoms, including ataxia and visual disturbances. She is found to have elevated levels of very long-chain fatty acids in her blood. Which of the following mechanisms could explain her condition?

1. Defective transport of fatty acids into mitochondria.
2. Impaired breakdown of fatty acids in peroxisomes.
3. Mutations in peroxin genes affecting multiple metabolic pathways.
4. Increased synthesis of plasmalogens leading to cellular toxicity.

Select all that apply.

A) 1 and 2

B) 2 and 3

C) 3 and 4

D) 1 and 4

Answer: B

A researcher is studying the effects of aging on mitochondrial function in muscle cells. She notes an increase in mitochondrial DNA mutations and a decline in ATP production. What conclusions can be drawn regarding mitochondrial dynamics?

1. Aging leads to enhanced fusion processes, improving mitochondrial quality.
2. Accumulation of mutations can impair the efficiency of oxidative phosphorylation.
3. Increased fission can facilitate the removal of damaged mitochondria.
4. The loss of cristae structure may result in decreased surface area for ATP synthesis.

Select all that apply.

A) 1 and 2

B) 2 and 4

C) 1 and 3

D) 3 and 4

Answer: B

A woman with a known mitochondrial disorder is pregnant. Genetic counseling reveals she carries both normal and mutant mitochondrial DNA. What implications does this have for her offspring?

1. Only daughters will inherit the condition due to maternal inheritance.
2. Offspring may exhibit variable expression of mitochondrial dysfunction.
3. Sons are less likely to be affected compared to daughters.
4. All offspring will inherit the same proportion of mutant mtDNA.

Select all that apply.

A) 1 and 3

B) 2 and 4

C) 2 and 3

D) 1 and 2

Answer: C

A newborn presents with hypotonia, seizures, and characteristic facial features. Genetic testing reveals mutations in PEX genes. What can be inferred about the child's condition?

1. This disorder is linked to impaired fatty acid oxidation.
2. Peroxisomes are likely to be absent or dysfunctional.
3. This condition may lead to the accumulation of toxic metabolites.
4. Treatment strategies will focus exclusively on dietary management.

Select all that apply.

A) 1 and 2

B) 2 and 3

C) 1 and 4

D) 3 and 4

Answer: B

A 12-year-old girl presents to the clinic with a history of recurrent seizures, progressive muscle weakness, developmental delay, and episodic vomiting. Her mother notes that she often experiences severe fatigue after physical exertion. Family history reveals that the mother has experienced unexplained muscle cramps and fatigue since her teenage years. A detailed physical examination shows ataxia, hypotonia, and mild cognitive impairment.

Laboratory Findings:

1. Elevated levels of lactate and pyruvate in the blood.
2. Abnormal results on MRI showing changes in the basal ganglia and cerebral cortex.
3. Elevated levels of very long-chain fatty acids in the plasma.
4. Genetic testing reveals a heteroplasmic mutation in mitochondrial DNA associated with a known mitochondrial disorder.

Questions:

1. **Given the patient's symptoms and laboratory findings, which of the following conditions is most likely to be contributing to her clinical presentation?**

    A) Mitochondrial myopathy

    B) Peroxisomal biogenesis disorder

    C) Pyruvate dehydrogenase deficiency

    D) A combined mitochondrial and peroxisomal disorder

2. **What is the significance of the elevated levels of very long-chain fatty acids in this patient?**

    A) They indicate impaired mitochondrial fatty acid oxidation.

    B) They suggest an increase in mitochondrial respiration.

    C) They are a sign of efficient peroxisomal metabolism.

    D) They have no relevance to her condition.

3. **Considering the maternal inheritance pattern of mitochondrial disorders, what is the most relevant implication for the patient's mother?**

    A) She will only pass on the condition to her daughters.

    B) The severity of the mother's symptoms is likely related to the percentage of mutant mtDNA.

C) The mother cannot pass on her mitochondrial condition to any offspring.

D) All of her children will be affected equally by the disorder.

4. **In managing this patient's condition, which of the following interventions would be most appropriate?**

   A) Restricting carbohydrate intake to reduce lactate levels.

   B) Supplementation with coenzyme Q10 and other mitochondrial support therapies.

   C) Initiating high-intensity exercise therapy to build muscle strength.

   D) Using a ketogenic diet to enhance fatty acid oxidation in mitochondria.

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Answers:

1. **Answer:** D
2. **Answer:** A
3. **Answer:** B
4. **Answer:** B

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