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Mitochondria

Exam — Cell Organelles

Pre-Med practice questions about mitochondrial structure, function, and inheritance

39 items — Printable Exam

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1 **Which statement about mitochondria in eukaryotic cells is correct?**

A They are part of the endomembrane system and receive most of their proteins in transport vesicles from the rough ER.

B They contain circular DNA and 70S ribosomes similar to those of bacteria.

C They are surrounded by a single membrane and lack their own genetic material.

D They are found only in animal cells and absent from plant cells.

E They synthesize all of the ATP produced in the cell, including that made during glycolysis.

2 **In a respiring mitochondrion, where is the proton gradient that directly drives ATP synthesis by ATP synthase established?**

A Across the outer mitochondrial membrane, with higher $[H^+]$ in the cytosol.

B Across the inner mitochondrial membrane, with higher $[H^+]$ in the intermembrane space than in the matrix.

C Between the mitochondrial matrix and the nucleoplasm.

D Across the plasma membrane, with higher $[H^+]$ outside the cell.

E Within the mitochondrial matrix, with protons concentrated around mitochondrial DNA.

3 **Which process occurs primarily in the mitochondrial matrix of a eukaryotic cell?**

A Glycolysis.

B Citric acid (Krebs) cycle.

C Electron transport along complexes I-IV.

D Lactic acid fermentation.

E Fatty acid synthesis from acetyl-CoA.

4 **A mutation in mitochondrial DNA severely reduces ATP production. Which pattern of inheritance is most consistent with this defect in humans?**

A Affected fathers transmit the mutation to all of their children, but affected mothers do not.

B Only male offspring can inherit the mutation.

C All children of an affected mother can inherit the mutation, but affected fathers do not transmit it.

D The mutation appears only when both parents are affected.

E The mutation always skips one generation before reappearing.

5 **A chemical uncoupler of oxidative phosphorylation allows protons to move freely across the inner mitochondrial membrane. Assuming abundant substrates and oxygen are available, what is the most immediate effect on mitochondrial function?**

A Electron transport and oxygen consumption stop completely.

B Electron transport and oxygen consumption increase, but ATP synthesis falls sharply.

C Both electron transport and ATP synthesis increase.

D The proton gradient across the inner membrane becomes steeper than normal.

E The citric acid cycle stops because NAD^+ is no longer regenerated.

6 **During active respiration, how do the pH and proton concentration of the mitochondrial matrix compare to those of the intermembrane space?**

A Matrix has lower pH and higher $[H^+]$ than the intermembrane space.

B Matrix has higher pH and lower $[H^+]$ than the intermembrane space.

C Matrix and intermembrane space always have identical pH and $[H^+]$.

D Matrix lacks protons entirely; all protons accumulate in the cytosol.

E Matrix initially has lower $[H^+]$, but this reverses once ATP synthase begins to function.

7 **A drug is added to isolated, actively respiring mitochondria supplied with abundant oxygen and substrates. The drug specifically inhibits ATP synthase (complex V) but does not directly affect complexes I–IV. Which of the following immediate responses is most likely?**

A Proton pumping across the inner mitochondrial membrane stops while oxygen consumption sharply increases.

B The proton gradient across the inner mitochondrial membrane increases initially, and oxygen consumption decreases.

C The proton gradient collapses immediately, but oxygen consumption remains unchanged.

D Both the proton gradient and oxygen consumption immediately increase.

E No change occurs because ATP synthase is not required for oxidative phosphorylation.

8 **A cultured mammalian cell line is engineered to completely lack functional mitochondria but retains all other cellular components. The cells are supplied with abundant glucose and oxygen. Which statement best describes their ATP production and metabolism of pyruvate under these conditions?**

A They generate almost the same ATP per glucose by greatly accelerating oxidative phosphorylation in the cytosol.

B They cannot regenerate NAD^+, so glycolysis quickly stops and ATP production falls to zero.

C They rely on glycolysis followed by conversion of pyruvate to lactate to regenerate NAD^+, yielding much less ATP per glucose.

D They shift citric acid cycle enzymes to the cytosol and maintain normal ATP yield per glucose.

E They switch to using peroxisomes for electron transport and ATP synthesis.

9 **A mitochondrial matrix enzyme is encoded by a nuclear gene and is normally synthesized in the cytosol with an N-terminal targeting sequence that directs it into mitochondria. A mutation removes this targeting sequence but leaves the rest of the protein unchanged. In which cellular compartment will the mutant enzyme most likely accumulate?**

A Mitochondrial matrix.

B Mitochondrial intermembrane space.

C Cytosol.

D Rough endoplasmic reticulum lumen.

E Peroxisomal matrix.

10 **Which mitochondrial structure contains most of the proteins of the electron transport chain and ATP synthase?**

A Outer mitochondrial membrane

B Inner mitochondrial membrane

C Intermembrane space

D Mitochondrial matrix

E Cytosol

11 **Cristae in mitochondria are best described as:**

A Invaginations of the outer membrane that store calcium

B Folds of the inner membrane that increase surface area for oxidative phosphorylation

C Infoldings of the plasma membrane that anchor mitochondria

D Stacks of membranes continuous with the rough ER

E Channels connecting the matrix directly to the cytosol

12 Which of the following human cell types would be expected to have the HIGHEST number of mitochondria?

A Red blood cell

B Cardiac muscle cell

C Mature fat (adipose) cell storing triglycerides

D Skin epidermal cell about to be shed

E Bacterial cell

13 Which statement about mammalian red blood cells (RBCs) and mitochondria is CORRECT?

A RBCs contain many mitochondria to support aerobic respiration

B RBCs contain a single large mitochondrion for ATP production

C RBCs lack mitochondria and rely mainly on glycolysis for ATP

D RBCs contain mitochondria but do not use them

E RBCs contain chloroplasts instead of mitochondria

14 In eukaryotic cells, the reactions of the citric acid (Krebs) cycle occur mainly in the:

A Cytosol

B Rough endoplasmic reticulum

C Golgi apparatus

D Mitochondrial matrix

E Intermembrane space

15 **Which combination of processes occurs primarily in mitochondria during aerobic respiration?**

A Glycolysis and fermentation

B Citric acid cycle, -oxidation of fatty acids and oxidative phosphorylation

C DNA replication and transcription of all nuclear genes

D Protein synthesis for all cellular proteins

E Glycolysis and DNA replication

16 **Which statement correctly describes the OUTER mitochondrial membrane?**

A It is highly impermeable to small molecules and ions

B It contains porin channels and is relatively permeable to small molecules

C It contains ATP synthase complexes

D It forms cristae to increase surface area

E It stores mitochondrial DNA

17 **Which feature provides strong evidence that mitochondria evolved from free-living bacteria (endosymbiotic theory)?**

A Presence of a single membrane and 80S ribosomes

B Possession of circular DNA and 70S ribosomes

C Ability to perform photosynthesis

D Absence of any genetic material

E Production of cellulose cell walls

18 **Which statement about mitochondrial DNA (mtDNA) is CORRECT in humans?**

A It is linear and packaged with histones like nuclear DNA

B It is circular and inherited almost exclusively from the mother

C It encodes all mitochondrial proteins

D It is found only in the nucleus

E It is present only in sperm cells

19 **A cell increases its energy demand over time (e.g., a training muscle cell). Which statement about mitochondria is MOST accurate?**

A The number and size of mitochondria are fixed and cannot change

B Mitochondria can proliferate by division, increasing their number

C Mitochondria can only be produced by the Golgi apparatus

D Mitochondria disappear when energy demand rises

E New mitochondria must be imported from the bloodstream

20 **In oxidative phosphorylation, the proton (H^+) gradient generated by the electron transport chain is located:**

A Across the nuclear envelope

B Between the mitochondrial matrix and intermembrane space

C Between the cytosol and extracellular fluid

D Across the outer mitochondrial membrane only

E Across the plasma membrane

21 **An uncoupling agent makes the inner mitochondrial membrane leaky to protons. What is the MOST DIRECT effect on mitochondrial function?**

A Electron transport stops immediately

B The proton gradient collapses and ATP production falls, with energy released mainly as heat

C The proton gradient increases and ATP production rises

D The citric acid cycle stops producing NADH

E Glycolysis is directly inhibited

22 **Brown adipose (fat) tissue in newborns contains many mitochondria with uncoupling protein (UCP1). Its main function is to:**

A Increase ATP production for muscle contraction

B Generate heat by allowing protons to leak and dissipate the gradient

C Store extra oxygen in hemoglobin

D Carry out photosynthesis

E Synthesize cholesterol

23 **In the mitochondrial electron transport chain, molecular oxygen (O_2) acts mainly as:**

A The initial electron donor

B A proton pump in Complex I

C The final electron acceptor, forming water

D A substrate of the citric acid cycle

E A competitive inhibitor of ATP synthase

24 **If oxygen supply to a cell is suddenly cut off, which mitochondrial process would be affected FIRST?**

A Glycolysis in the cytosol

B Electron transport and oxidative phosphorylation

C DNA replication in the nucleus

D Protein synthesis on rough ER

E All mitochondrial functions would immediately continue unaffected

25 **Protons flow THROUGH ATP synthase in mitochondria from:**

A Intermembrane space into the matrix

B Matrix into the intermembrane space

C Cytosol into the intermembrane space

D Nucleus into the cytosol

E Endoplasmic reticulum into the matrix

26 Which step in aerobic respiration directly links glycolysis in the cytosol to the citric acid cycle in the mitochondrion?

A Conversion of glucose to glucose-6-phosphate

B Conversion of pyruvate to acetyl-CoA in the mitochondrial matrix

C Formation of lactate from pyruvate

D Binding of oxygen to hemoglobin

E Conversion of CO_2 to bicarbonate

27 Which of the following is NOT a typical function of mitochondria?

A ATP production via oxidative phosphorylation

B Participation in apoptosis (programmed cell death)

C Heat production in brown fat

D Synthesis and modification of secreted proteins for export

E Regulation of intracellular calcium levels

28 In apoptosis, mitochondria can initiate cell death by releasing which molecule into the cytosol?

A ATP synthase

B Cytochrome c

C Glucose

D DNA polymerase

E Lactate dehydrogenase

29 **A woman has a disease caused by a mutation in her mitochondrial DNA. Which pattern of inheritance is most expected for her children?**

A Only her sons can inherit the disease

B Only her daughters can inherit the disease

C All her children (sons and daughters) may inherit the disease

D None of her children can inherit the disease

E Only children of her husband will inherit the disease

30 **Which statement correctly describes the compartments of a mitochondrion?**

A The matrix lies between the outer and inner membranes

B The intermembrane space lies between the outer and inner membranes

C Cristae are folds of the outer membrane

D The cytosol is another name for the mitochondrial matrix

E The inner membrane is continuous with the nuclear envelope

31 **Which process of glucose metabolism does NOT take place inside mitochondria?**

A Citric acid cycle

B Oxidative phosphorylation

C Conversion of pyruvate to acetyl-CoA

D Glycolysis

E -oxidation of fatty acids

32 **Which statement about mitochondrial replication is MOST accurate?**

A Mitochondria are formed de novo from the plasma membrane

B Mitochondria divide by a process resembling bacterial binary fission

C Mitochondria can only replicate during S phase with nuclear DNA

D Each cell synthesizes mitochondria from free lipids and proteins in the cytosol

E Mitochondria can be synthesized only in the Golgi apparatus

33 **Which of the following tissues would be MOST severely affected by a general defect in mitochondrial ATP production?**

A Cartilage in the ear

B Cardiac and skeletal muscle

C Outer layer of dead skin cells

D Mature red blood cells

E Hair shaft keratin

34 **Which statement about mitochondria in PLANT cells is CORRECT?**

A Plant cells lack mitochondria because they have chloroplasts instead

B Plant mitochondria produce ATP by oxidative phosphorylation, just as in animal cells

C Plant mitochondria are responsible for photosynthesis

D Plant cells use only chloroplasts for all ATP needs

E Plant mitochondria contain no DNA

35 **Which combination correctly links mitochondrial NADH and $FADH_2$ to ATP yield in oxidative phosphorylation (assuming ideal conditions)?**

A NADH contributes more ATP per molecule than $FADH_2$

B $FADH_2$ contributes more ATP per molecule than NADH

C Both contribute exactly the same ATP per molecule

D Neither NADH nor $FADH_2$ contributes electrons to the ETC

E Only $FADH_2$ enters the ETC

36 **Which statement best explains why mitochondrial diseases often show variable severity among tissues in the same individual?**

A Mitochondria are evenly distributed and function identically in all tissues

B All tissues have identical energy demands

C Different tissues have different energy requirements and may contain different proportions of mutant vs normal mitochondria

D Only the liver contains mitochondria

E Mitochondrial DNA mutations always affect only the skin

37 Which of the following best describes the role of mitochondria in aerobic vs anaerobic respiration?

A Mitochondria are essential for aerobic respiration but not required for anaerobic glycolysis

B Mitochondria are essential for anaerobic respiration but not for aerobic

C Both aerobic and anaerobic ATP production occur exclusively in mitochondria

D Anaerobic ATP production is impossible in human cells

E Aerobic respiration occurs only in the cytosol

38 Which statement about the SELECTIVITY of the inner mitochondrial membrane is CORRECT?

A It is freely permeable to all small ions and molecules

B It is highly selective and contains specific transport proteins for many metabolites

C It contains porin channels that allow any molecule to pass

D It is composed mainly of cellulose

E It is absent in mature mitochondria

39 Which of the following BEST explains why mitochondria are often found clustered near regions of high ATP use, such as the flagellum of a sperm cell?

A Mitochondria release oxygen directly into those regions

B Mitochondria can only function if they are attached to microtubules

C Localisation near high-demand regions reduces the distance ATP must diffuse to reach energy-requiring processes

D Mitochondria are immobile and cannot change position in the cell

E ATP is toxic if distributed evenly in the cell

#	Ans	Answer Text
1	B	They contain circular DNA and 70S ribosomes similar to those of bacteria...
2	B	Across the inner mitochondrial membrane, with higher [H^+] in the interme...
3	B	Citric acid (Krebs) cycle.
4	C	All children of an affected mother can inherit the mutation, but affecte...
5	B	Electron transport and oxygen consumption increase, but ATP synthesis fa...
6	B	Matrix has higher pH and lower [H^+] than the intermembrane space.
7	B	The proton gradient across the inner mitochondrial membrane increases in...
8	C	They rely on glycolysis followed by conversion of pyruvate to lactate to...
9	C	Cytosol.
10	B	Inner mitochondrial membrane
11	B	Folds of the inner membrane that increase surface area for oxidative pho...
12	B	Cardiac muscle cell
13	C	RBCs lack mitochondria and rely mainly on glycolysis for ATP
14	D	Mitochondrial matrix
15	B	Citric acid cycle, -oxidation of fatty acids and oxidative phosphorylat...
16	B	It contains porin channels and is relatively permeable to small molecule...
17	B	Possession of circular DNA and 70S ribosomes
18	B	It is circular and inherited almost exclusively from the mother
19	B	Mitochondria can proliferate by division, increasing their number
20	B	Between the mitochondrial matrix and intermembrane space
21	B	The proton gradient collapses and ATP production falls, with energy rele...
22	B	Generate heat by allowing protons to leak and dissipate the gradient
23	C	The final electron acceptor, forming water
24	B	Electron transport and oxidative phosphorylation
25	A	Intermembrane space into the matrix
26	B	Conversion of pyruvate to acetyl-CoA in the mitochondrial matrix
27	D	Synthesis and modification of secreted proteins for export
28	B	Cytochrome c
29	C	All her children (sons and daughters) may inherit the disease
30	B	The intermembrane space lies between the outer and inner membranes
31	D	Glycolysis
32	B	Mitochondria divide by a process resembling bacterial binary fission
33	B	Cardiac and skeletal muscle
34	B	Plant mitochondria produce ATP by oxidative phosphorylation, just as in ...
35	A	NADH contributes more ATP per molecule than $FADH_2$
36	C	Different tissues have different energy requirements and may contain dif...
37	A	Mitochondria are essential for aerobic respiration but not required for ...
38		It is highly selective and contains specific transport proteins for many...