AP BIO INSTA-REVIEW

TOPIC 3.6

Cellular Respiration

ENE-1.K.1

Fermentation and cellular respiration use energy from biological macromolecules to produce ATP. Respiration and fermentation are characteristic of all forms of life.

ENE-1.K.2

Cellular respiration in eukaryotes involves a series of coordinated enzyme-catalyzed reactions that capture energy from biological macromolecules.

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Cellular Respiration

ENE-1.K.3

The electron transport chain transfers energy from electrons in a series of coupled reactions that establish an electrochemical gradient across membranes–

a. Electron transport chain reactions occur in chloroplasts, mitochondria, and prokaryotic plasma membranes.

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Cellular Respiration

ENE-1.K.3

b. In cellular respiration, electrons delivered by NADH and $FADH_2$ are passed to a series of electron acceptors as they move toward the terminal electron acceptor, oxygen. In photosynthesis, the terminal electron acceptor is $NADP^+$. Aerobic prokaryotes use oxygen as a terminal electron acceptor, while anaerobic prokaryotes use other molecules.

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Cellular Respiration

ENE-1.K.3

c. The transfer of electrons is accompanied by the formation of a proton gradient across the inner mitochondrial membrane or the internal membrane of chloroplasts, with the membrane(s) separating a region of high proton concentration from a region of low proton concentration. In prokaryotes, the passage of electrons is accompanied by the movement of protons across the plasma membrane.

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Cellular Respiration

ENE-1.K.3

d. The flow of protons back through membrane-bound ATP synthase by chemiosmosis drives the formation of ATP from ADP and inorganic phosphate. This is known as oxidative phosphorylation in cellular respiration, and photophosphorylation in photosynthesis.

e. In cellular respiration, decoupling oxidative phosphorylation from electron transport generates heat. This heat can be used by endothermic organisms to regulate body temperature.

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Cellular Respiration

ENE-1.L.1

Glycolysis is a biochemical pathway that releases energy in glucose to form ATP from ADP and inorganic phosphate, NADH from NAD^+, and pyruvate.

ENE-1.L.2

Pyruvate is transported from the cytosol to the mitochondrion, where further oxidation occurs.

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Cellular Respiration

ENE-1.L.3

In the Krebs cycle, carbon dioxide is released from organic intermediates, ATP is synthesized from ADP and inorganic phosphate, and electrons are transferred to the coenzymes NADH and $FADH_2$.

ENE-1.L.4

Electrons extracted in glycolysis and Krebs cycle reactions are transferred by NADH and $FADH_2$ to the electron transport chain in the inner mitochondrial membrane.

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Cellular Respiration

ENE-1.L.5

When electrons are transferred between molecules in a sequence of reactions as they pass through the ETC, an electrochemical gradient of protons (hydrogen ions) across the inner mitochondrial membrane is established.

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Cellular Respiration

ENE-1.L.6

Fermentation allows glycolysis to proceed in the absence of oxygen and produces organic molecules, including alcohol and lactic acid, as waste products.

ENE-1.L.7

The conversion of ATP to ADP releases energy, which is used to power many metabolic processes.

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Which step is anaerobic?

A. Glycolysis

B. Krebs Cycle

C. Oxidative Phosphorylation

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Which step is anaerobic?

A. Glycolysis

Anaerobic means that it occurs without oxygen. Glycolysis takes place in the cytosol and does not require oxygen. Fermentation is able to regenerate the NAD^+ for glycolysis. Krebs Cycle and Oxidative Phosphorylation take place in the mitochondria and require oxygen.

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Where does glycolysis take place?

A. Chloroplast

B. Cytosol

C. Mitochondria

D. Nucleus

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Where does glycolysis take place?

B. Cytosol

Glycolysis takes place in the cytosol. This process can take place in all cells due to all cells having cytosol.

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How does glycolysis taking place in the cytosol prove that glycolysis was the first evolved metabolic step?

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How does glycolysis taking place in the cytosol prove that glycolysis was the first evolved metabolic step?

All organisms undergo glycolysis.

Glycolysis takes place in the cytosol and does not require membrane bound organelles. Evolved before the membrane bound organisms since the process does not need it.

Glycolysis does not require oxygen. Pre-historic earth did not have oxygen and so it evolved before oxygen was found in the atmosphere.

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Fermentation synthesizes ATP...

A. True

B. False

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Fermentation synthesizes ATP...

B. False

Fermentation is required to regenerate the NAD^+ in the absence of O_2. This process takes place after glycolysis which synthesizes 2 ATP molecules.

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What is the function of fermentation?

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What is the function of fermentation?

To regenerate the NAD^+ that is needed for cellular respiration steps.

NAD^+ takes an electron (and a hydrogen) to become reduced. This NADH is the electron shuttle around the steps of Cellular Respiration. If all the NADH is reduced there is no available NAD^+ and the processes will halt. Fermentation allows the NADH to offload the electrons (and become oxidized)

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Where does Krebs Cycle take place?

A. Cristae

B. Cytosol

C. Intermembrane space

D. Matrix

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Where does Krebs Cycle take place?

D. Matrix

The Krebs cycle takes place in the mitochondrial matrix. The pyruvate is transported into the mitochondria through a transport protein.

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Where does the electron transport chain of cellular respiration occur?

A. Cristae

B. Cytosol

C. Intermembrane space

D. Matrix

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Where does the electron transport chain of cellular respiration occur?

A. Cristae

The electron transport chain takes place in the inner mitochondrial membrane called the cristae. This is where the cytochromes will pass the electron which creates the proton gradient between the IM space and matrix.

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ATP is synthesized in the electron transport chain...

A. True

B. False

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ATP is synthesized in the electron transport chain...

B. False

There is NO ATP synthesized in the electron transport chain. The ATP is synthesized during chemiosmosis due to the proton gradient formed from the electron transport chain.

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If the ETC doesn't make ATP, what is the function of the electron transport chain?

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If the ETC doesn't make ATP, what is the function of the electron transport chain?

ETC generates the proton gradient that is used in chemiosmosis to synthesize ATP from ADP.

Proton gradient is the concentration gradient of the protons on one side of the membrane resulting in a potential energy that is used to add the terminal phosphate to the ADP molecule.

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Which side has the high proton concentration?

A. Cristae

B. Cytosol

C. Intermembrane space

D. Matrix

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Which side has the high proton concentration?

C. Intermembrane space

The protons are pumped out of the mitochondrial matrix and into the intermembrane (IM) space during the electron transport chain. As the electron releases energy, it pumps the protons against their concentration gradient.

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What is the first step of cellular respiration?

A. Glycolysis

B. Krebs Cycle

C. Oxidative Phosphorylation

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What is the first step of cellular respiration?

A. Glycolysis

Glycolysis is the first step of cellular respiration. In this step, the glucose molecule is split into two pyruvates and synthesizes 2 NADH & 2 ATP

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What is the starting material for glycolysis?

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What is the starting material for glycolysis?

Glucose

(NAD^+ & ADP)

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What are the products of glycolysis?

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What are the products of glycolysis?

2 pyruvate
2 ATP
2 NADH

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Why is the step of glycolysis important?

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Why is the step of glycolysis important?

Provide NADH with high energy electrons to shuttle to the ETC in the mitochondria

Break down glucose into pyruvate for the next step

Substrate level phosphorylation of ATP

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What is the second step of cellular respiration?

A. Glycolysis

B. Krebs Cycle

C. Oxidative Phosphorylation

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What is the second step of cellular respiration?

B. Krebs Cycle

The acetyl CoA product from pyruvate oxidation enters the Krebs cycle which synthesizes 3 NADH, 1 $FADH_2$, 1 ATP, and releases 2 CO_2 from 1 molecule of pyruvate.

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What step occurs between glycolysis and the Krebs cycle?

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What step occurs between glycolysis and the Krebs cycle?

Pyruvate oxidation

Where the pyruvate is oxidized (loses electron to NADH) and loses a CO_2 then adds a coenzyme to make Acetyl CoA

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How many of the 2 carbons from acetyl CoA remain after Krebs Cycle?

A. 0
B. 1
C. 2
D. 3

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How many of the 2 carbons from acetyl CoA remain after Krebs Cycle?

A. 0

There are 2 carbons that enter the Krebs cycle as acetyl CoA and 2 carbon that leave the Krebs cycle as CO_2. There are NO carbons remaining from acetyl CoA.

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What is the function of the Krebs Cycle?

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What is the function of the Krebs Cycle?

To complete the breakdown of "glucose" by releasing the remaining carbons as CO_2

Provide more high energy electrons to ETC with NADH and $FADH_2$

Substrate level phosphorylation for ATP

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What two parts make up oxidative phosphorylation?

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What two parts make up oxidative phosphorylation?

Electron Transport Chain
Chemiosmosis

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During ETC, protons are pumped across the cristae. How does the pH in the mitochondria compare?

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During ETC, protons are pumped across the cristae. How does the pH in the mitochondria compare?

The pH of the matrix is higher than the pH of the intermembrane space.

The protons are pumped OUT of the matrix INTO the intermembrane space. As the concentration increases in the IM space, pH the decreases.

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Which enzyme in the cristae adds the P to ADP?

A. ADP Phosphorylase

B. ATP Synthase

C. Kinase

D. Phosphatase

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TOPIC 3.6

Which enzyme in the cristae adds the P to ADP?

B. ATP Synthase

Recall, enzymes tells you what they do. ATP Synthase is the enzyme that will synthesize ATP.

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Which process precedes fermentation?

A. Calvin Cycle

B. Glycolysis

C. Krebs Cycle

D. Oxidative Phosphorylation

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Which process precedes fermentation?

B. Glycolysis

Fermentation is an anaerobic process to regenerate the NAD^+ molecules. This step takes place after glycolysis.

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What is the function of fermentation?

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What is the function of fermentation?

To regenerate the NAD^+

The process of glycolysis will allow for NADH to be reduced as glucose is oxidized. If the cell is not going through the electron transport chain, it will be unable to oxidize the NADH back to NAD^+.

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Identify the three steps of cellular respiration

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Identify the three steps of cellular respiration

Glycolysis

Krebs Cycle

Oxidative Phosphorylation

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Prokaryotes perform an electron transport chain on their plasma membrane

A. True

B. False

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Prokaryotes perform an electron transport chain on their plasma membrane

A. True

The outer membrane of a prokaryote is the inner membrane of a mitochondria (recall the endosymbiotic theory). This means that the electron transport chain will take place on the plasma membrane of prokaryotes.

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Which is the pathway of the electron through cellular respiration?

A. CO_2 > NADH > NADPH

B. Glucose > NADH > O_2

C. NADH > O_2 > Glucose

D. Water > ATP > NADPH

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Which is the pathway of the electron through cellular respiration?

B. Glucose > NADH > O_2

Glucose enters and is oxidized to form pyruvate. When the electrons are removed, they reduce NAD^+ to NADH which carries the electron to the electron transport chain. At the end of the electron transport chain is an oxygen molecule to be the final electron acceptor.

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What is the final electron acceptor in cellular respiration?

A. ATP

B. NADH

C. Oxygen

D. Water

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What is the final electron acceptor in cellular respiration?

C. Oxygen

In aerobic respiration, the final electron acceptor is oxygen. The oxygen will be reduced and bond with hydrogen ions to form water.

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What donates the electron in photosynthesis?

A. ATP

B. NADH

C. Oxygen

D. Water

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What donates the electron in photosynthesis?

D. Water

In photosynthesis, the electrons are donated by the water molecule when it is split during photolysis in Photosystem II.

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Where are the electrons pumped during the electron transport chain in the mitochondria?

A. Cytosol

B. Stroma

C. Matrix

D. Intermembrane space

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Where are the electrons pumped during the electron transport chain in the mitochondria?

D. Intermembrane space

The electrons are pumped into the intermembrane (IM) space. This is a small space which allows the concentration to increase quickly to allow the generation of ATP through ATP synthase.

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Describe how endotherms and ectotherms differ in their work to maintain body temperatures.

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Describe how endotherms and ectotherms differ in their work to maintain body temperatures.

Endotherms use metabolism to maintain a higher body temperature than their environment

Ectotherms use behaviors to regulate internal body temperature

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Krebs cycle: products?

A. ATP, NADH, $FADH_2$, CO_2

B. ATP, 2 NADH, 2 $FADH_2$, CO_2

C. ATP, 3 NADH, $FADH_2$, 2 CO_2

D. 2 ATP, NADH, $FADH_2$, 2 CO_2

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Krebs cycle: products?

C. ATP, 3 NADH, $FADH_2$, 2 CO_2

After 1 turn of the Krebs cycle, there are 3 NADH, 2 CO_2, 1 ATP, 1 $FADH_2$