Cell Respiration Notes

An Overview

- _____ reactions and _____ pathway
- Energy _____ in bonds of food molecules is _____
- Cellular respiration provides the energy to make ATP from ADP and Phosphate
- Carbs, proteins, & lipids can be _____ as fuel in cellular respiration
- Cells must _____ its ATP to do cellular work
- Occurs in the _____

Mitochondria

- Function: site of energy capture and transformation (cell respiration)
  - Quantity in the cell is _____ with metabolic activity
- Structure: double membrane (phospholipid bilayer)
  - Inner folds = _____; contain enzymes used in ATP production
  - _____ lies between the cristae and the outer membrane and the _____ makes up the middle of the mitochondrion
  - Contains its own DNA and can divide on its own

Principles of Energy Harvest

- Catabolic pathway
  - Cellular Respiration
    -
    - Can be from the breakdown of carbs, lipids, or proteins
  - _____ – occurs in the absence of _____
  - Energy from these reactions are either used to do work or released as heat

Oxidizing Agent in Respiration

- _____ (nicotinamide adenine dinucleotide) and _____ (flavin adenine dinucleotide)
  - NAD+ is reduced to NADH, then _____ to make ATP in the final step of cell respiration
    - Same process occurs with $FADH_2$

Pathway of Electrons

- Electrons are removed from _____ through a series of reactions to eventually get added to _____ to make _____
- Electron pathway:

Types of Phosphorylation

- Substrate-level Phosphorylation
  - Type of phosphorylation in which a phosphate group is transferred from an _____ compound to the _____ compound (ATP)
- Oxidative Phosphorylation
  - Type of phosphorylation in which an _____ is added to ADP to form ATP through the _____ of a molecule

Cellular Respiration – 2 Types

- Aerobic – _____ is used in the production of ATP
  - Glycolysis →formation of Acetyl CoA→ Krebs Cycle → ETC
- Anaerobic – no O_2 is present in the production of ATP; referred to as _____
  - _____ only

4 Steps of Aerobic Cellular Respiration

STEP 1: Glycolysis = "_____"

- Glucose – a 6C sugar, is split to form 2 molecules of _____ – a 3C sugar
- Occurs in the _____
- Catabolic pathway that decomposes glucose and other organic fuels
- 10 steps divided into 2 phases:
    - **Energy investment phase**
        - Cell _____ in initial breakdown of glucose
    - **Energy payoff phase**
        - ATP is produced by _____ level phosphorylation and NAD+ is reduced to NADH by electrons released from the breakdown of food
- Net energy yield
    - 2 _____ produced
    - 2 _____ produced

Types of Fermentation

- **Alcohol Fermentation** – form of anaerobic respiration that converts glucose into _____ and _____ by yeasts, fungi, or bacteria
    - Used in the production of alcoholic beverages and bread
- **Lactic Acid Fermentation**: form of anaerobic respiration that converts glucose into _____ by animals and some bacteria
    - Used in the dairy industry to make cheese & yogurt.
    - Human muscle cells create lactic acid & ATP

STEP 2 – Formation of Acetyl CoA

- The junction between glycolysis and the Kreb's Cycle
- Pyruvate enters the _____ where it is oxidized into Acetyl CoA
    - Electrons are _____ in the form of _____
- Overall Reaction of Pyruvate → acetyl CoA:
    - **2 pyruvate + 2 NAD^+ + 2 CoA → _____ + 2NADH + 2 CO_2**

Steps of Acetyl CoA Formation

1. Pyruvate's _____ group (COO-) is removed and given off as a molecule of CO_2.
2. Remaining 2C fragment is _____ (electron is lost) forming a compound named _____
    - An enzyme transfers the "lost" electrons to NAD+ forming _____
3. _____, a sulfur-containing compound (derived from Vitamin B) is attached to the acetate by an unstable bond which makes the attached acetyl group highly reactive.

STEP 3 – Krebs Cycle

- A metabolic "furnace" that is also known as the Citric Acid Cycle
- Krebs Cycle reactions oxidize the remaining acetyl CoA into CO_2
- The Krebs Cycle is composed of 8 enzyme-controlled steps.
    - Two turns of the Krebs Cycle produces:
        - 2 _____
        - 6 _____ (1 NADH is equal to 3 ATP)
        - 2 _____ (1 $FADH_2$ 1.5 ATP)
- **Remember**: In Glycolysis, one molecule of glucose is partially oxidized into 2 molecules of pyruvate. Each of the 2 pyruvate molecules are then converted to Acetyl CoA which enters the Krebs cycle.

STEP 4 – Electron Transport Chain (ETC)

- Electron carrier molecules - membrane _____ in the cristae
- Shuttles electrons that release energy used to make ATP through _____
- Sequence of reactions that prevents energy being released in 1 explosive step

- Together, glycolysis and Krebs Cycle have produced only a net gain of _____ ATP molecules
- NADH & $FADH_2$ which gained electrons in these processes will _____ in the ETC to form the rest of the ~36 ATP made from _____.
    - NADH & $FADH_2$ will donate their electrons to the system of electron carrier molecules embedded in the _____ of the mitochondrial membrane.
    - **Remember**: cristae _____ for chemical reactions to occur
- Most of the ETC is composed of various proteins that remove _____ from NADH and $FADH_2$ to create an _____ between the intermembrane space and the mitochondrial matrix.
    - This proton gradient is maintained because the membrane's bilayer is impermeable to H^+, thus preventing diffusion back to the matrix

Chemiosmosis

- _____ uses the potential energy stored in a proton gradient to make _____ by allowing _____, back across the membrane
    - This provides the power to allow the _____ of ADP and Pi into ATP.

Versatility of Catabolic Reactions

- Cell respiration can utilize other molecules from food to start the process
    - Proteins are broken into amino acids with _____ removed, which feeds into glycolysis or Krebs
    - Carbs such as _____ is broken down to glucose, which feeds into glycolysis
    - Fats are broken into _____ and _____
        - Glycerol is changed to G3P (simple sugar)
        - Fatty acids are broken into acetyl CoA

Cell Respiration Regulation

- _____ feedback mechanism
- One of the enzymes in glycolysis is an _____ enzyme
    - Products made will bind to the enzyme and inhibit the activity