Upward Bound
Summer 2021

Topic 04

Cellular Respiration

Learning Objectives

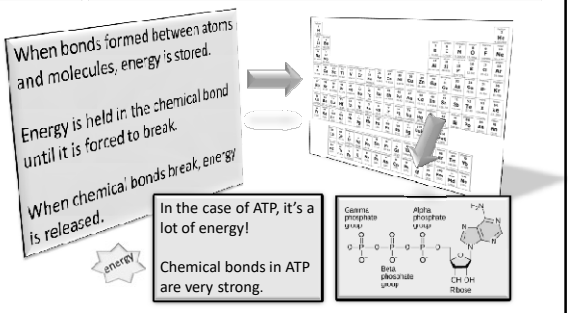
At the end of this module, students will be able to:

- Describe key concepts of cellular respiration
- Sketch conceptual diagram of cellular respiration
- Contrast glycolysis to the Krebs cycle
- Connect respiration to physiology concepts

Outline

a. Underlying concepts
b. Key words
c. Diagrams
d. Discussion
e. Work packet

04.a Underlying concept



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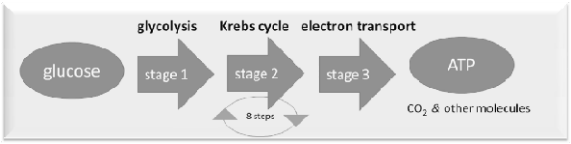
04.a Underlying concept



$$ATP + H_2O \rightarrow ADP + P_i + \text{free energy}$$

04.b Key words

carbohydrate
6 calories/gram

organic compounds in foods and living tissues including sugars, starch, and cellulose. They contain hydrogen and oxygen in the same ratio as water (2:1) and an be broken down to release energy in the animal body.

protein
6 calories/gram

substance with amino acids, carbon, hydrogen, oxygen, & nitrogen found in many foods. They are essential in diet animal diets for the growth and repair of tissue. Found in meat, fish, eggs, milk, and legumes.

fat
9 calories/gram

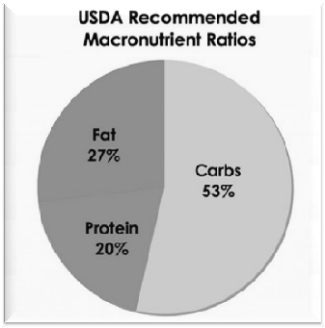
nutrients (triglycerides)used in metabolism. Fat provides essential fatty acids, which the body can't make. Some fats are healthy - others are not. Fats have nine calories per gram. Limit fat to 30% daily intake.

04.b Key words

carbohydrate
6 calories/gram

protein
6 calories/gram

fat
9 calories/gram



04.b Key words

glucose

Glucose is a simple sugar with the molecular formula $C_6H_{12}O_6$. Glucose is the most abundant monosaccharide, a subcategory of carbohydrates.

pyruvic acid

a central substance related to carbohydrates, protein and fat in catabolism and anabolism. It's a product of glycosis (anaerobic glucose metabolism). Pyruvic acid, becomes part of the Krebs cycle.

oxygen

part of the aerobic metabolism during the Kreb cycle.

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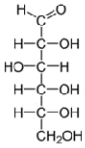
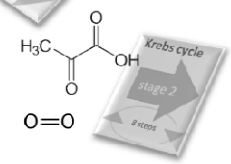
04.b Key words

glucose
Simple sugar



pyruvic acid
the simplest of the alpha-keto acids



aerobic
0_2 is normal diatomic oxygen

O=O

04.b Key words

metabolism	refers to all chemical reactions that occur in living organisms (e.g., digestion and transport of substances between cells). These are catabolic or anabolic.
anabolism	the building up (synthesis) of compounds (such as proteins, carbohydrates, lipids, and nucleic acids). anabolism consumes energy.
catabolism	the breaking down of compounds (e.g., breaking down of glucose to pyruvate by cellular respiration). Digestion is a type of catabolism. Catabolism releases energy.

04.b Key words

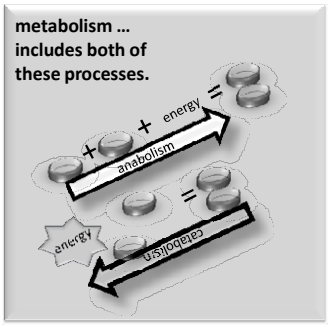
metabolism
chemical reactions in living things

&

anabolism
process that consume energy

catabolism
process that release energy

metabolism … includes both of these processes.



04.b Key words

glycolysis
in the cytoplasm.

the process in which glucose is broken down to produce energy. It produces two molecules of pyruvate, ATP, NADH and water. Glycolysis is a type of catabolism. *catabolism*

Krebs cycle
in the mitochondria

These reactions are in the mitochondrial matrix (dense solution surrounding mitochondria crests). In addition to water, the matrix contains enzymes and phosphates needed for the cycle's chemical reactions.

electron transport
in the mitochondria

Electron transport chain. The electron transport chain is the last stage of the respiration pathway. It is the stage that produces the most ATP molecules.

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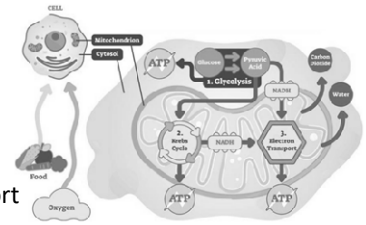
04.b Key words

glycolysis

Krebs cycle

electron transport



04.b Key words

mitochondrion a double membrane-bound organelle found in most eukaryotic organisms. Mitochondria generate most of the cell's supply of adenosine triphosphate (ATP), used as a source of chemical energy.

cytosol also known as intracellular fluid (ICF) or cytoplasmic matrix, is the liquid found inside cells. It is a complex water-based solution in which organelles, proteins, and other cell structures float.

cytoplasm consists of cytosol – and the organelles – the cell's internal sub-structures. Cytoplasm is a jelly-like material that makes up much of a cell inside the cell membrane, and surrounds the nucleus.

04.b Key words

mitochondrion

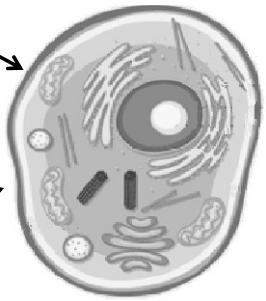
where Krebs cycle takes place

cytosol

where pyruvate is formed then imported to the mitochondria.

cytoplasm

where glycolysis takes place



04.b Key words

ATP Is the energy currency of life and provides energy for most biological processes when converted to ADP (adenosine diphosphate).

ADP ADP is converted to ATP for the storing of energy by adding a high-energy phosphate group. This takes place in the cytoplasm and/or in the mitochondria.

NADH The role of NADH is critical in oxidative metabolism, a process in which cells are broken down to generate energy. For instance, breakdown of energy-yielding nutrients, such as glucose, requires NADH.

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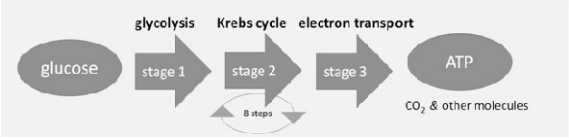
04.a Key words

hydrolysis
a type of catabolism. takes place in the mitochondria

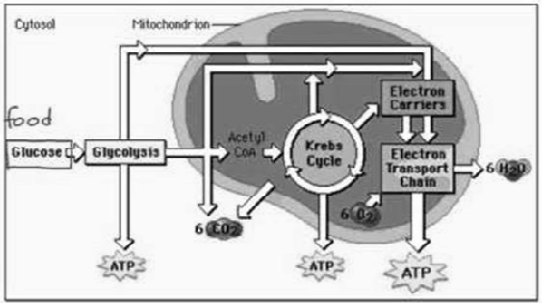
chemical breakdown of a compound reacting with water. Catabolism is the breaking apart of molecules to smaller molecules to release energy. In humans, 60% of energy from hydrolysis of ATP produces metabolic heat.

04.c Diagrams

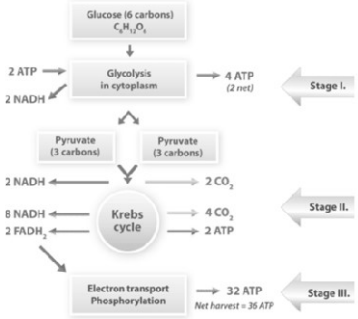


Step 1: Citrate synthase. ...
Step 2: Aconitase. ...
Step 3: Isocitrate dehydrogenase. ...
Step 4: α-Ketoglutarate dehydrogenase. ...
Step 5: Succinyl-CoA synthetase. ...
Step 6: Succinate dehydrogenase. ...
Step 7: Fumarase. ...
Step 8: Malate dehydrogenase.

04.c Diagrams



04.c Diagrams



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04.d Discussion

Eventually fats, protein, and carbohydrates can all become cellular energy.

The process is not the same for each macronutrient, but the end results does yield power for the cell.

It just isn't as straightforward and direct for fats and proteins to turn into ATP.

Sugars and simple carbohydrates are easy.

Fats and proteins need to be broken down into simpler subunits before they can participate in cellular energy production. Fats are chemically converted into fatty acids and glycerol.

Proteins are slimmed down to amino acids—their building blocks.

There are nutrients you eat that don't get digested or used for ATP production, like fiber. Your body isn't equipped with the right enzymes to fully break down fiber. So, that material passes through the digestive system and leaves the body as waste.

04.e Workpacket