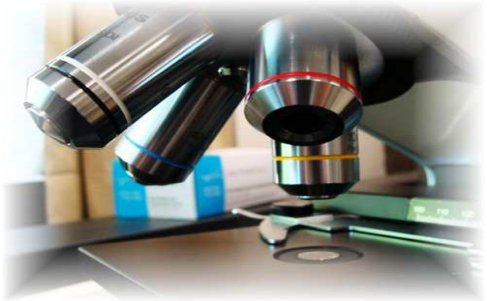

About Science Prof Online PowerPoint Resources

• Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.

• The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.

• Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.

• Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.

• Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.

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Image: Compound microscope objectives, T. Port

Metabolism

Cellular Respiration & Fermentation

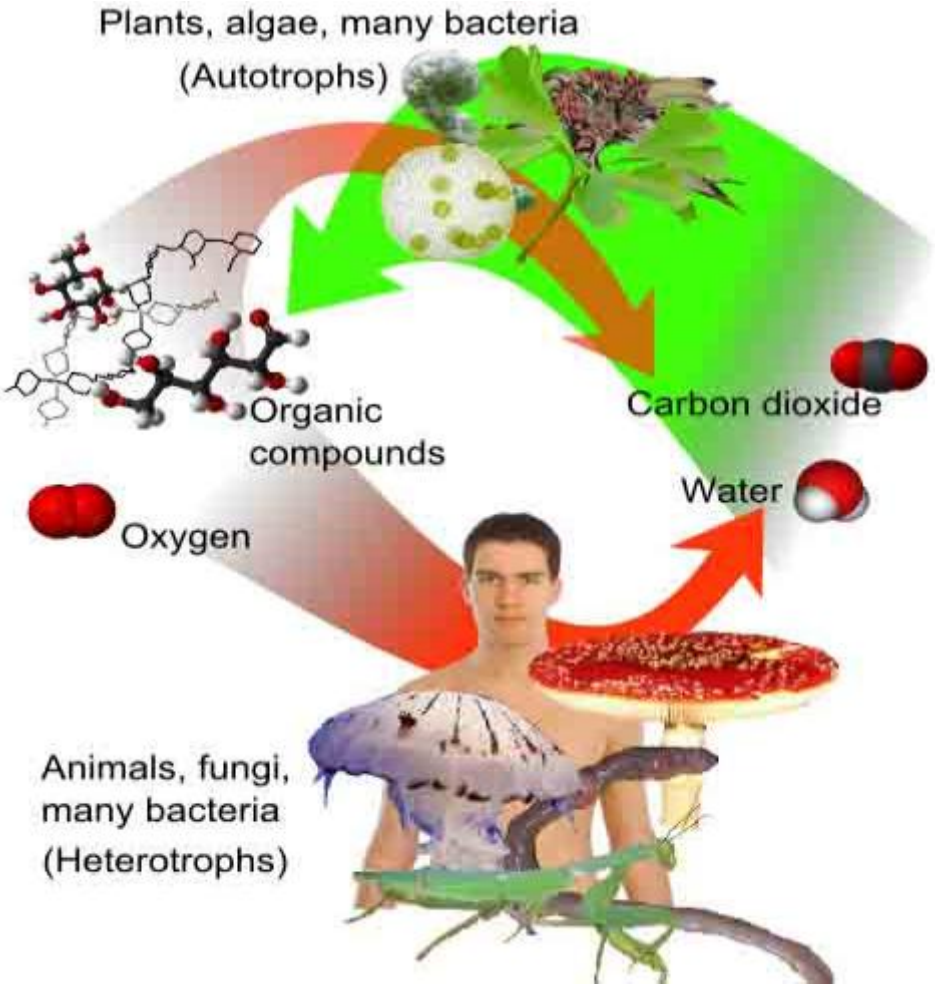


Image: Autotrophs & Heterotrophs, Mikael Häggström

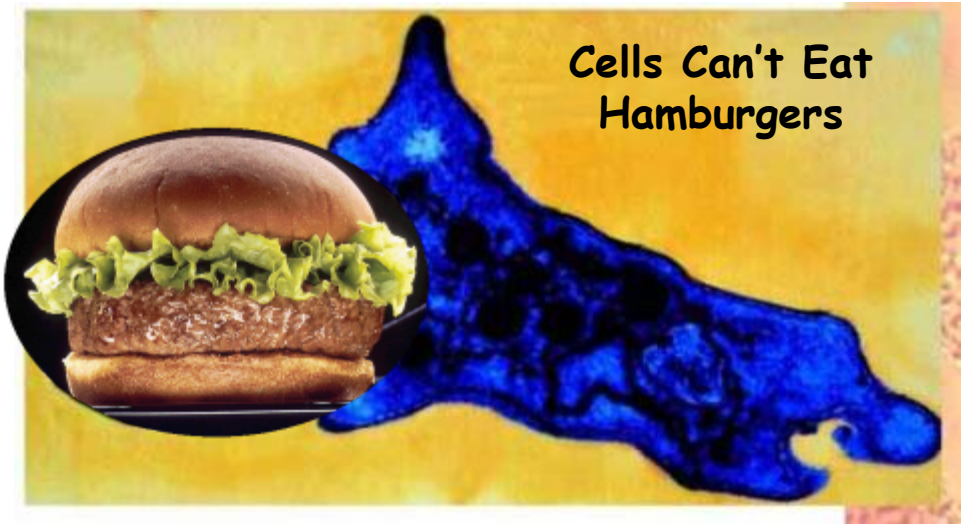
Metabolism

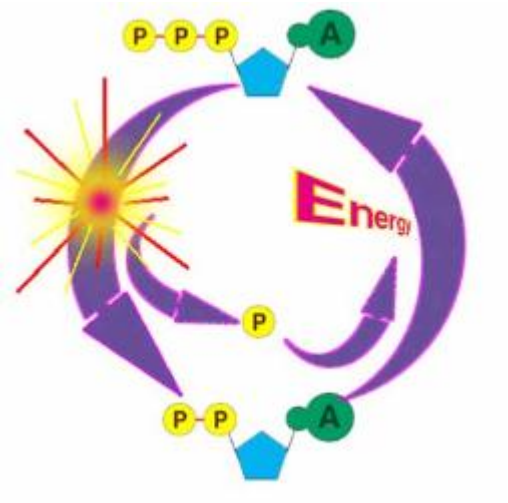
The Transformation of Energy

- Cells either get their energy either by **photosynthesis** or by **eating stuff**.

- But a cell can't just use sunlight or nutrients to run cellular reactions.

Q: What type of fuel is needed to run a cell?

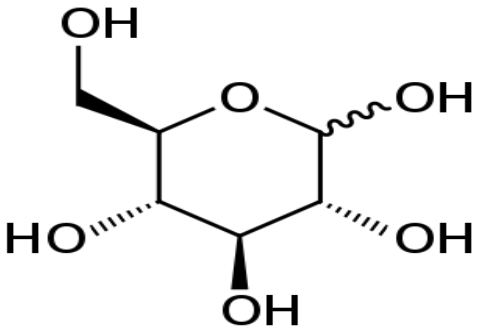




Images: Hamburger, Wiki; ATP-ADP Cycle, CUNY

Metabolism

Energy is obtained by breaking chemical bonds in foods we eat, like **glucose**.



Metabolism transfers food energy into ATP energy, the common energy currency of cells.

Image: Leo after pouring baby food on his head ☺, T. Port

Building and Breaking Down Molecules

Anabolic Reaction

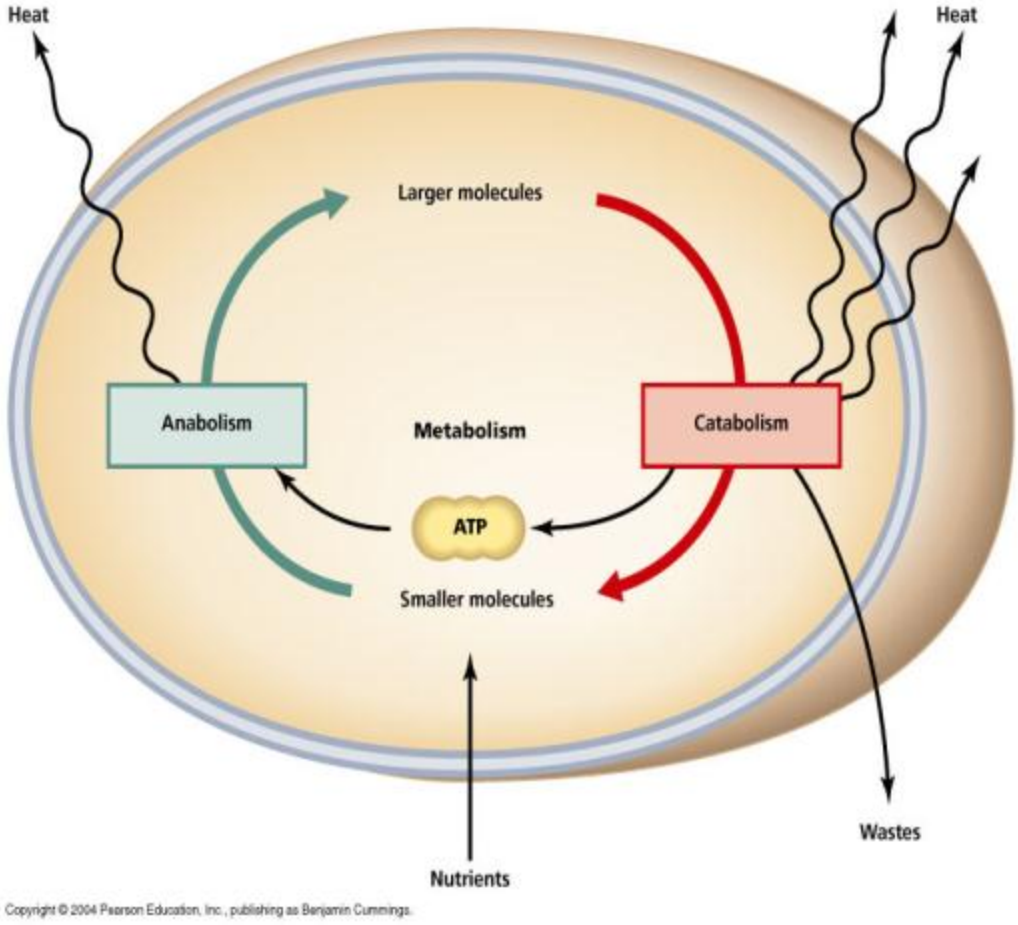
(anabolism)

The phase of metabolism in which simple substances are **synthesized** into the complex materials of living tissue.

Catabolic Reaction

(catabolism)

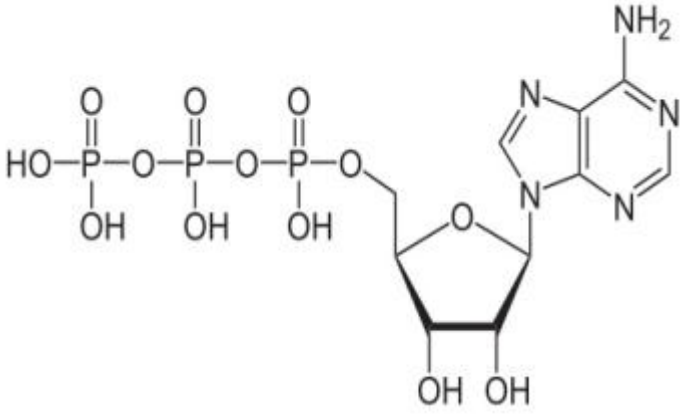
The metabolic **break down** of complex molecules into simpler ones, often resulting in release of energy.



ATP

Production & Energy Storage

Q: This molecule has a sugar, a base and three phosphate groups. What kind of monomer is it?



- Adenosine 5'-triphosphate
- Multifunctional "molecular currency" of intracellular energy transfer.
- Metabolism releases energy from nutrients.
- That energy can be stored in high-energy phosphate bonds of ATP.
- ATP transports chemical energy within cells.
- ATP can be used to fuel many cellular reactions.

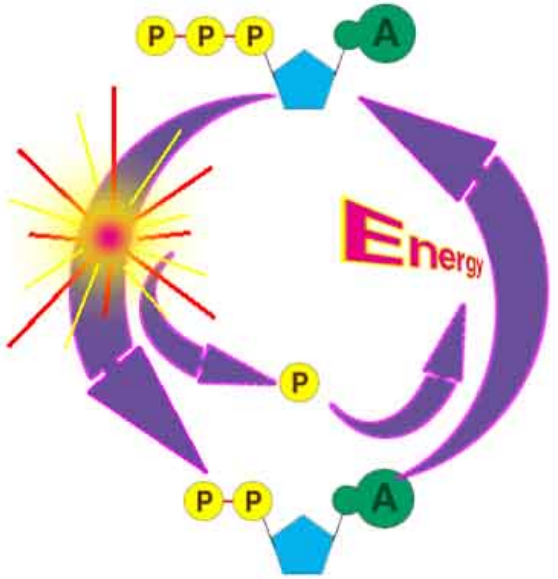
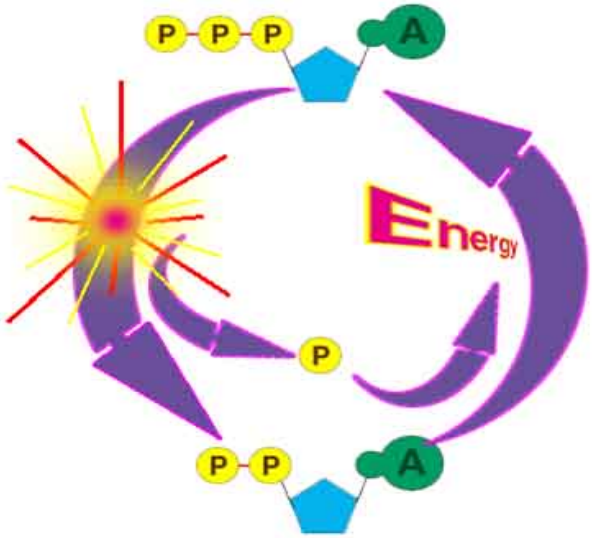
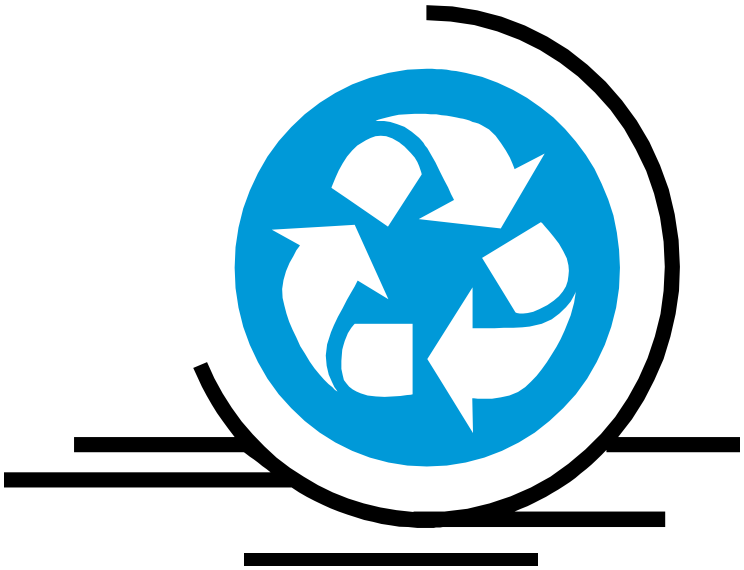


Image: ATP Molecule, NEUROtiker; ATP-ADP Cycle,

ATP

Production & Energy Storage





- In a working muscle cell the entire pool of ATP is recycled once each minute.
- Over 10 million ATP per second per cell.
- A biological "rechargeable battery!

Images: ATP molecule, NEUROtiker; ATP-ADP Cycle, CUNY

Aerobic Cellular Respiration *is* Carbohydrate Catabolism

- Organisms **catabolize** (break down) **carbohydrates** as the primary energy source for anabolic reactions.
- The monosaccharide **glucose** is used most commonly.
- Glucose catabolized by:
  - **Aerobic cellular respiration** → Results in complete breakdown of glucose to carbon dioxide, water and a lot of

  - **Anaerobic respiration & Fermentation** → Only partially breaks down glucose, into pyruvic acid and organic waste products and a little

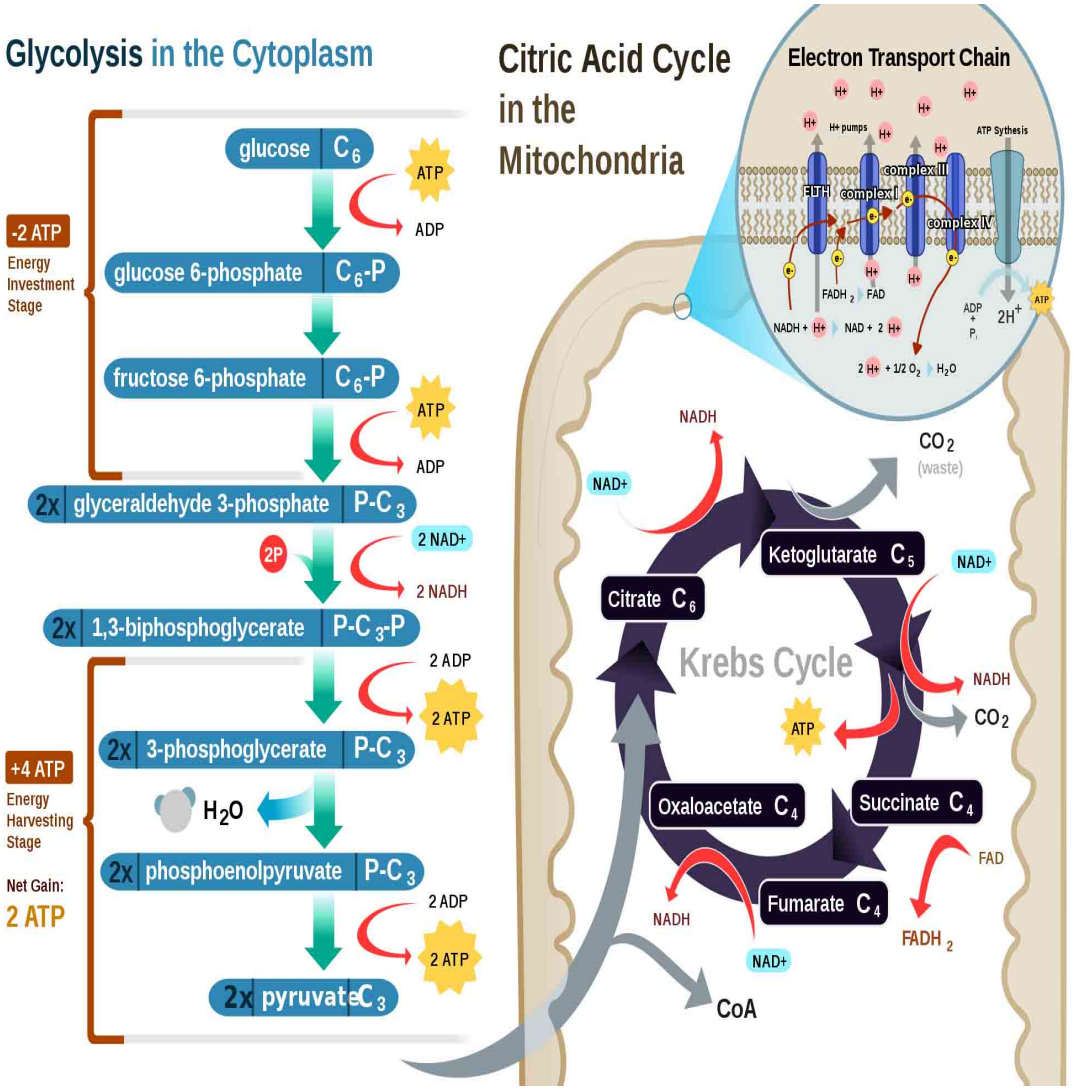
Aerobic cellular respiration →

In the presence of oxygen, breaks down glucose into carbon dioxide, water & **ATP**

The ultimate objective is to make **ATP** molecules to do cellular work.

In aerobic respiration, total of **38 molecules of ATP** are formed from one molecule of glucose.

Aerobic Cellular Respiration



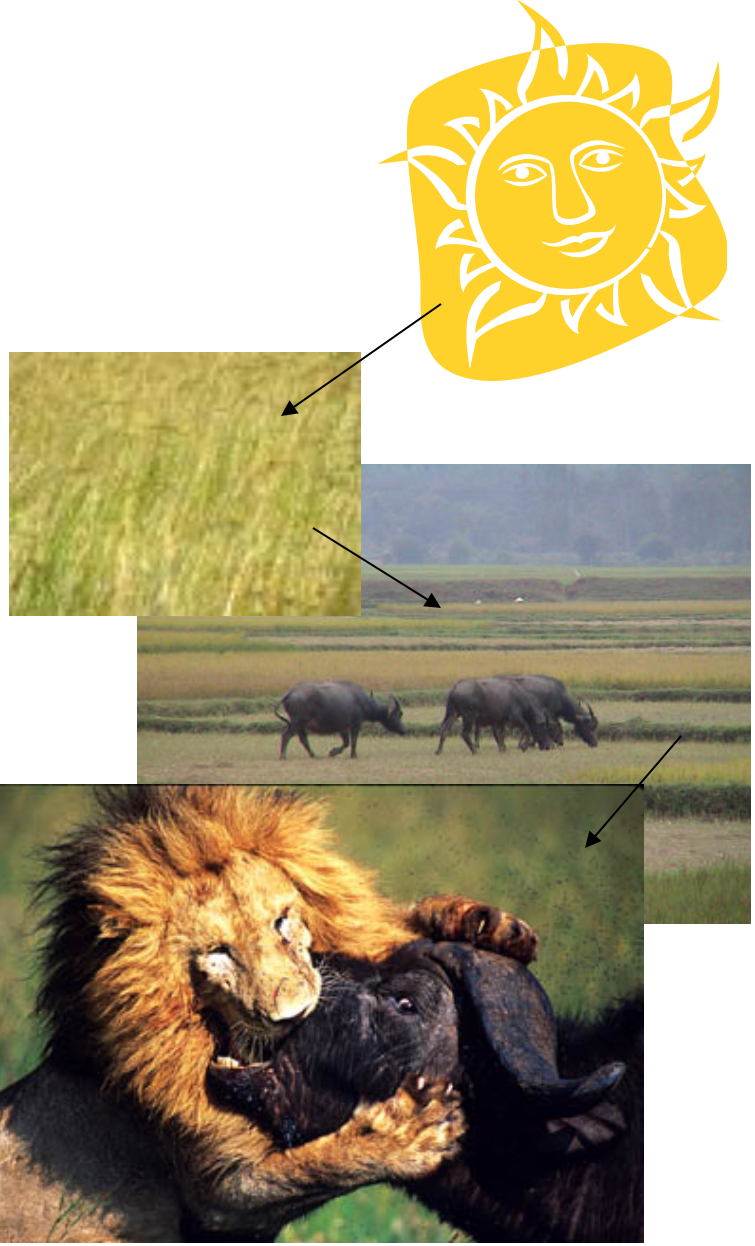
REVIEW!

Animated lesson and quizzes on Cellular Respiration

Image: Cellular Respiration, Regis Frey

Where does the energy come from?

In other words, how do we get glucose to begin with?



Autotroph - organism that makes organic compounds from inorganic sources.

Plants, some bacteria, and some protista make their own food using light energy.

Heterotroph - organism that cannot make organic compounds from inorganic sources.

They obtain their organic compounds by consuming other organisms. Almost all animals, fungi and some Protista and bacteria.

Sun → Autotroph → Heterotroph

Conversion of Energy

- Every food chain begins with **anabolic** pathways in organisms that synthesize their own **organic molecules** from inorganic carbon dioxide.

- Most of these organisms capture light energy from the sun and use it to drive the synthesis of **glucose** from CO_2 and H_2O by a process called photosynthesis.

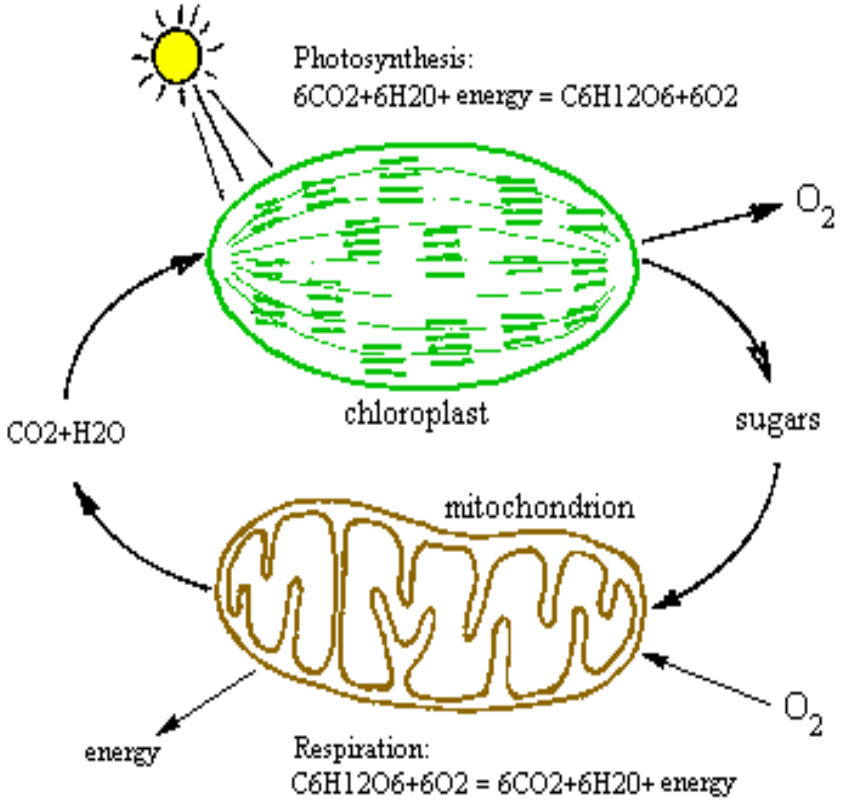
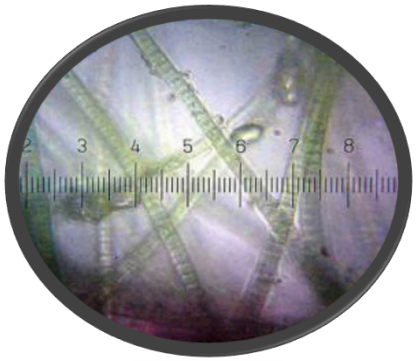
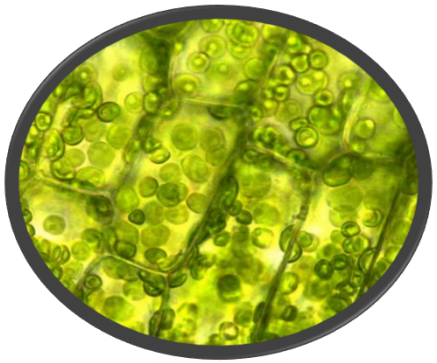


Figure 16 - With the photosynthesis, the solar energy is cumulated by the chloroplasts as sugar molecules. With the glycolysis and the respiration, made by mitochondria, the energy is liberated and supplied to the cell for its biochemical processes.

Cells that Run on Solar Power

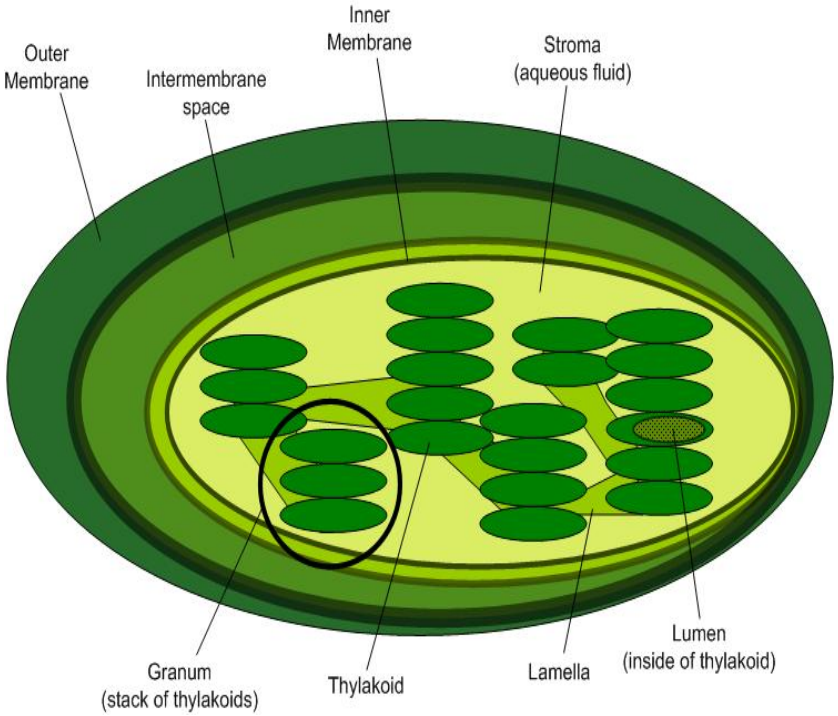


Cyanobacteria are photosynthetic bacteria.



Elodea plant cells with chloroplasts visible.

- Organisms capture light energy with pigment molecules; primarily **chlorophyll**.
- Prokaryotic autotrophs have chlorophyll in their cytoplasm.
- Eukaryotic autotrophs have chlorophyll organized in special photosystems within **chloroplast** organelles.



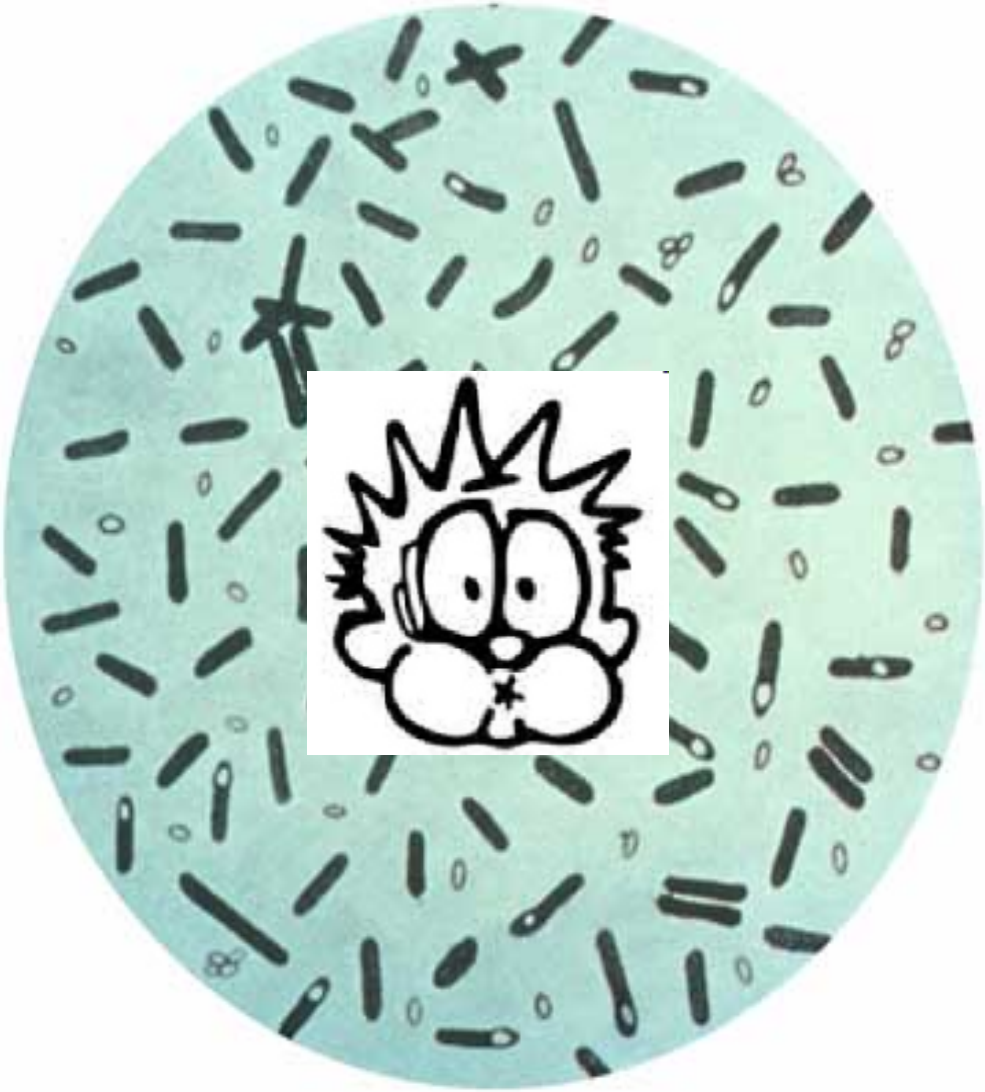
Images: Cyanobacteria, Bob Baylock; Elodea plant cells, T. Port Chloroplast diagram, Wiki

If oxygen is required for aerobic cellular respiration…

how do cells get **energy** if there is no

O_2,

or if they can't use oxygen?



Images: Clostridium botulinum, CDC; Calvin holding breath, Bill

Metabolism

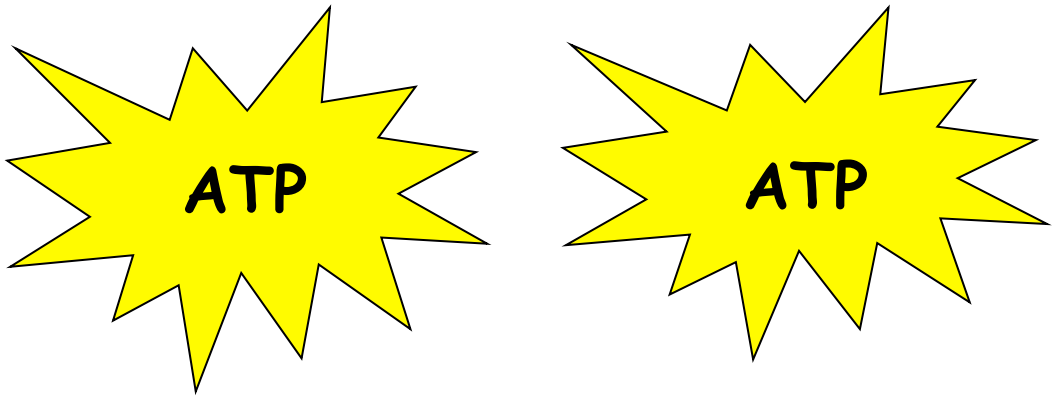
Anaerobic Cellular Respiration

&

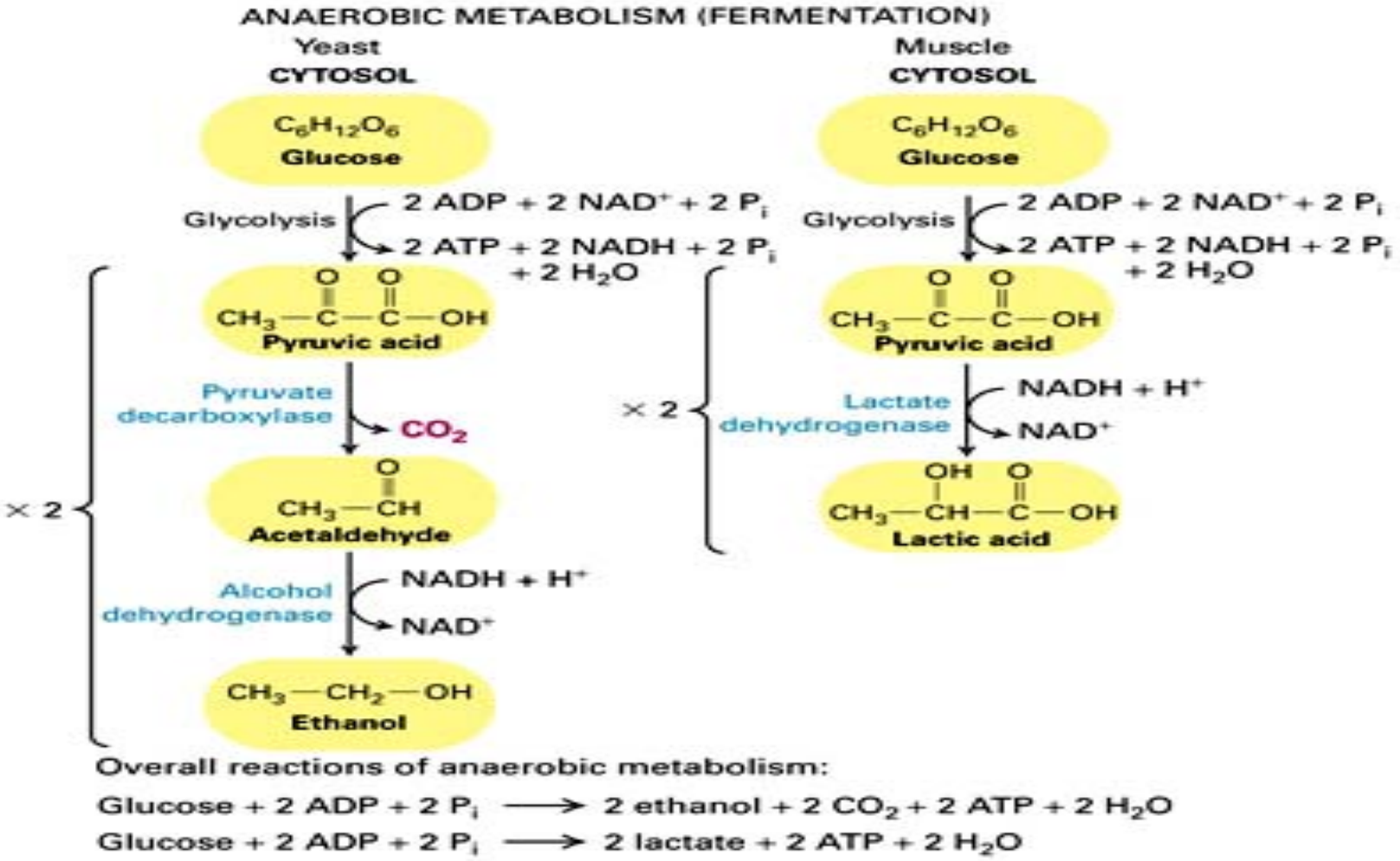
Fermentation

Fermentation

- Fermentation is an alternative system that allows glycolysis to continue without cellular respiration.
- Not as energetically efficient as respiration.
- Produces only 2 ATP.



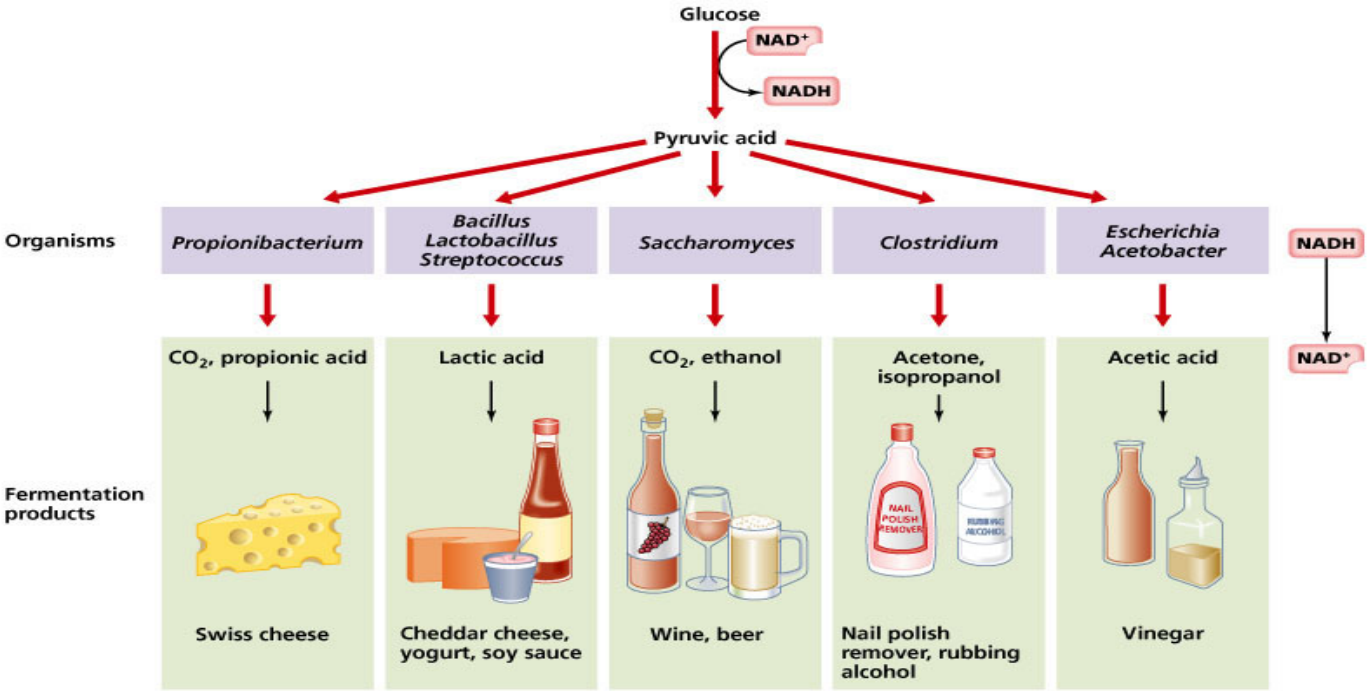
Fermentation



Fermentation

- Most of the potential energy remains in the bonds of fermentation products.

- Fermentation products are wastes to cells that make them, many are useful to humans (ethanol, acetic acid, and lactic acid).



Metabolic Processes … Bottom Line

Metabolism transforms food energy into energy that our cells can use.

Q: What carbohydrate molecule is the basic component of your food energy?

Q: What is different about how animal cells and plant cells obtain this molecule?

Q:What molecule is the product of metabolism used to do cellular work?

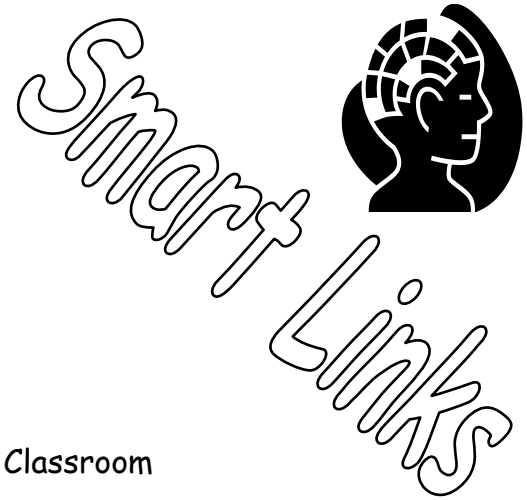
Image: Jumping rope, Meagan E. Klein

Everyday Biology

What causes smelly farts?

- Most people pass gas at least 10 – 25x a day.
- Farts are mostly a byproduct microbial anaerobic respiration & fermentation in the colon (large intestine).
- Over 99% of fart volume is non-smelly gases, including oxygen, nitrogen, carbon dioxide, hydrogen and methane.
- Smelly farts are caused by microbes that generate volatile sulfur compounds and/or by feces in the rectum.
- Diets high in healthy sulfur containing veggies *(ex. broccoli, cabbage, brussel sprouts)* and protein with sulfur-containing amino acids significantly increase the smell of farts.

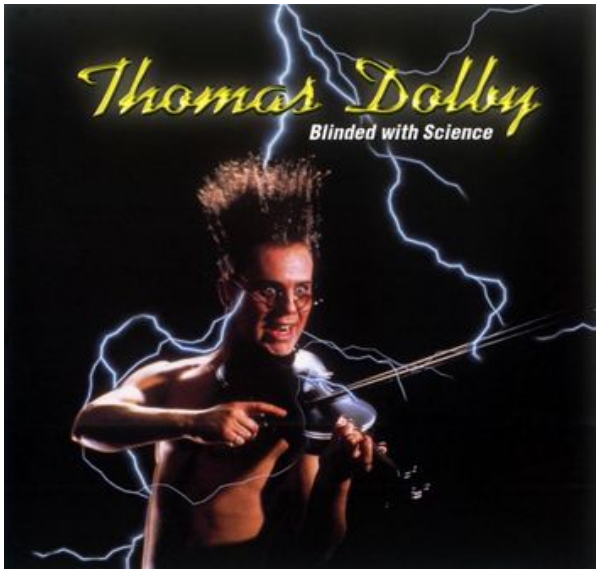
Confused?



Here are links to fun resources that further explain cellular respiration:

- Aerobic Cellular Respiration **Main Page** on the Virtual Cell Biology Classroom of Science Prof Online.
- Cellular Respiration animation by Jay Phelan, "What is Life? A Guide to Biology", W. H. Freeman & Co.
- "The Body Machine" music video by School House Rock.
- How NAD+ Works animation and quiz from McGraw-Hill.
- Glycolysis animation and quiz from McGraw-Hill.
- Krebs Cycle Animation & Quiz from McGraw-Hill.
- Electron Transport Chain animation from Molecular & Cellular Biology Learning Center.
- Electron Transport Chain click through animation by Graham Kent Bio231 Cell Biology Laboratory.
- Food Molecules video from HowStuffWorks, a Discovery company.
- "The Energy" song by Audiovent.

(You must be in PPT slideshow view to click on links.)

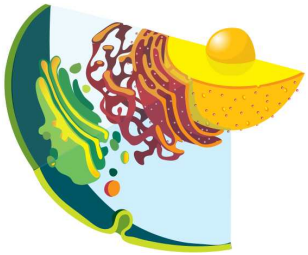


Are you feeling blinded by science?

Do yourself a favor. Use the…

Virtual Cell Biology Classroom *(VBC)* !

The VBC is full of resources to help you succeed, including:



- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the VCBC by going to the Science Prof Online website
www.ScienceProfOnline.com

Images: Blinded With Science album, Thomas Dolby; Endomembrane system, Mariana Ruiz, Wiki