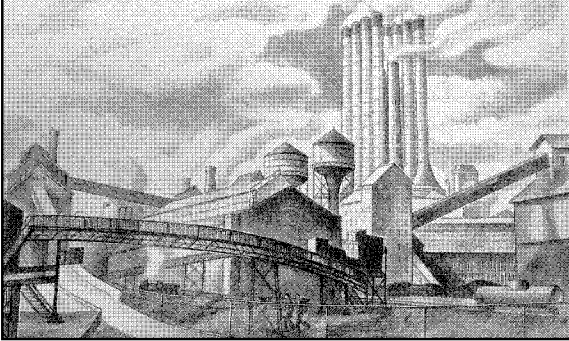


Wednesday, October 13  
Metabolism



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### Metabolism Key Concepts

- 1) Metabolism is the set of chemical processes that provide energy or nutrients for cells.
- 2) Autotrophs get their carbon from  $\text{CO}_2$ ; heterotrophs get their carbon by eating.
- 3) Organisms can get their energy from sunlight (photo-) or from chemical reactions (chemo-).

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**CHON:** The primary elements of life are Carbon, Hydrogen, Oxygen, & Nitrogen.

Carbon ("organic") chemistry is the basis of life.  
Water ( $\text{H}_2\text{O}$ ) is the universal solvent of life.  
Nitrogen is a key component of amino acids & DNA.

Other elements are also needed:



P – Phosphorus (DNA, RNA, & ATP/ADP)



S – Sulfur (some amino acids)

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**Metabolism:** The chemical reactions that occur in cells to provide energy and nutrients.

Metabolism needs a source of **raw materials:** molecules that provide the cell with C, H, O, N, etc...



Metabolism needs a source of **energy:** fuel for the processes that convert raw material into protein, lipids, carbohydrates...

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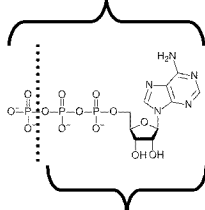
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Adenosine triphosphate (**ATP**) is the main energy source in cells.

adenosine **triphosphate** (ATP)



adenosine **diphosphate** (ADP)

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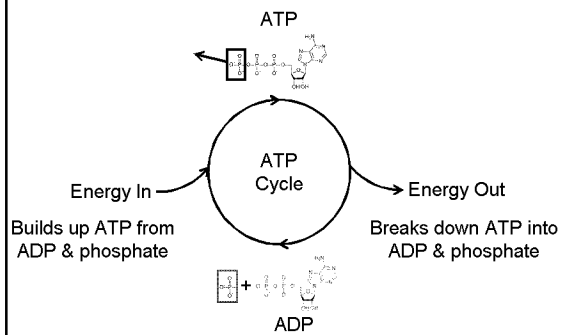
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The **ATP Cycle** is the “engine” of cellular chemistry.



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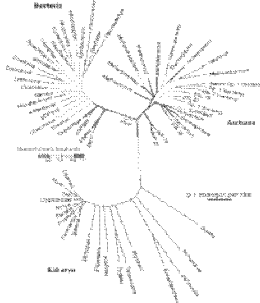
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All living cells on Earth use the ATP cycle for storage and transport of energy.

More evidence of a common ancestor for all life on Earth.

There are other possible energy cycles that could be used, but aren't.



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Questions to ask about an organism living on Earth:

What's the source of its carbon?

It can come from atmospheric CO<sub>2</sub>, or it can come from eating organic compounds.

What's the source of its energy?

It can come from sunlight, or it can come from oxidizing ("burning") chemicals.

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**Heterotrophs** are organisms that get their carbon by "eating" organic compounds.

**Chemoheterotrophs** also get energy from organic compounds.

Examples: animals, fungi, many bacteria



**Photoheterotrophs** get energy from sunlight.

Examples: *Chloroflexi* bacteria, heliobacteria (very rare)

*Chloroflexus aurantiacus*

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**Autotrophs** are organisms that get their carbon from  $\text{CO}_2$ .

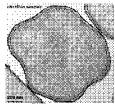


The  $\text{CO}_2$  can be in the air, or dissolved in water.

**Photoautotrophs** use energy from sunlight.



Examples: plants & photosynthetic bacteria



**Chemoautotrophs** use energy from oxidation of inorganic chemicals (iron, sulfur, ammonia).

Examples: some bacteria and archaea

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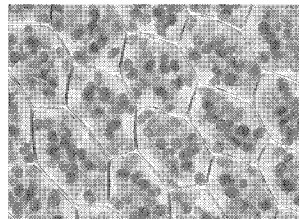
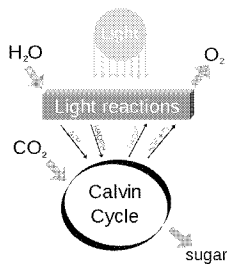
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**Photosynthesis** (occurring in photoautotrophs) is the conversion of  $\text{CO}_2$  &  $\text{H}_2\text{O}$  into  $\text{O}_2$  & sugars.

Sunlight provides the energy.



Moss cells containing chloroplasts.

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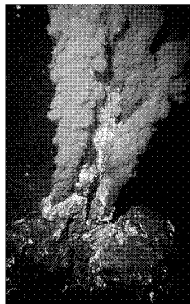
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**Chemosynthesis** (in chemoautotrophs) is the conversion of  $\text{CO}_2$  into organic compounds.

Oxidation of inorganic compounds or methane provides the energy.

Many chemoautotrophs are in the deep ocean near volcanic vents, which provide inorganic compounds.

Chemoautotrophs may have been the first forms of life on Earth.



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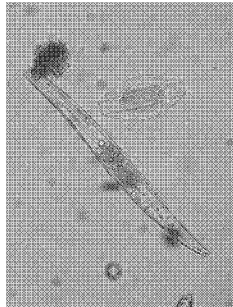
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The chemistry of life seems to work best in a liquid solvent.

It provides a medium for chemical reactions

It carries nutrients in and wastes out

It helps maintain a proper thermal balance.



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Liquid **water** is the ideal solvent for the chemistry of life.

Water is abundant.

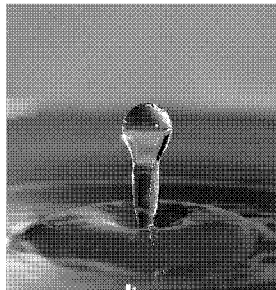
It's liquid from 0 – 100°C (ideal for most reactions).

It dissolves most chemicals.

It has large heat capacity.

It becomes less dense when it freezes.

It has high surface tension.



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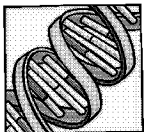
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Tomorrow's Lecture:



Heredity



This Week's Reading:

Chapter 5

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