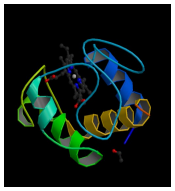
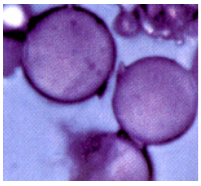
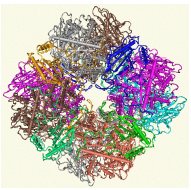
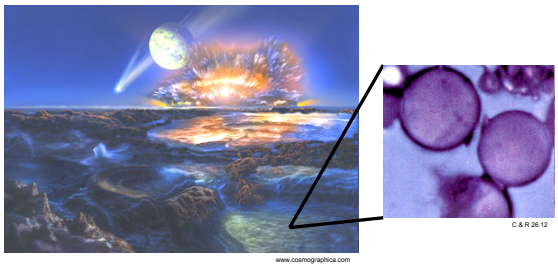
Thermodynamics
Group Active Engagement (GAE)

1. Tape defines your study group – sit with friends, or make new friends. Share cell numbers, email addresses, and potential meeting times (M-W) for working on homework outside of class.
2. Pre-class attitude survey – due now on Monday 1/31 http://perg-surveys.physics.umd.edu/MBEXpre.php or connect via attitudes surveys link in course menu on class website.
3. Diagnostic exam also now due on Monday 1/31.
4. Find 1st HW assignment "University Expectations" at GAE assignment link on course menu. Due Friday 2/4

Thermodynamics of Living Systems: Bioenergetics, Metabolism, and Order

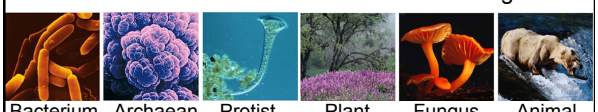
Imagine you were the first life form on Earth 4.3 billion years ago



What are the potential energy sources available to life?

Living Systems and Thermodynamics Laws

1) Organisms exhibit more energy transformations than any non-living entity.
2) Organisms exhibit more chemical reactions than any non-living entity.
3) Thermodynamics specifies the general rules for energy transformations and chemical reactions.
4) Genomes encode for the specific mechanisms, namely the molecules, responsible for energy transformations and chemical reactions in organisms



Thermodynamics GAE (Group Active Engagement)

Developing skills	Conceptual models for major principles	In-class small-group activities	Group homework
Group dynamics	Biological energy flow; thermodynamic laws	Flow diagramming; brainstorming	Apply for solving problems

Learning objectives:

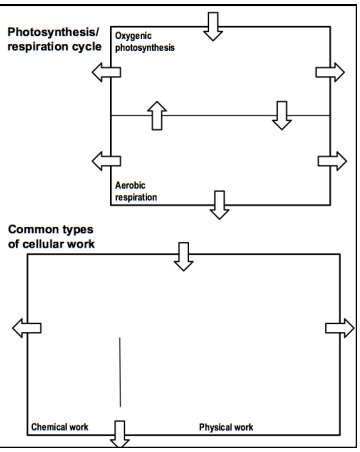
1) To assemble prior knowledge in order to construct flow diagrams of energy flow through biological systems;
2) To identify the fundamental rules governing biological E flow;
3) To translate those rules into the formalism of thermodynamics;
4) To apply thermodynamics equations for describing biological processes in class discussions and on group homework

Homework – Study group discussion (sometime Monday-Wednesday), and individual writing (after that discussion and due Friday 2/4)

Flow diagramming of energy flows in the biological world

1) Place the terms on the flow charts in a realistic sequence, and connect the terms with arrows.

2) Write consensus charts in your in-class worksheet.



Energy flows in the biological world

Instructions: Place these terms and add connecting arrows in the proper places in the charts depicting biological energy flows. *A term may be used several times.*

Photosynthesis/respiration cycle:

Terms : ATP, CO_2, glucose, heat, H_2O, light, O_2

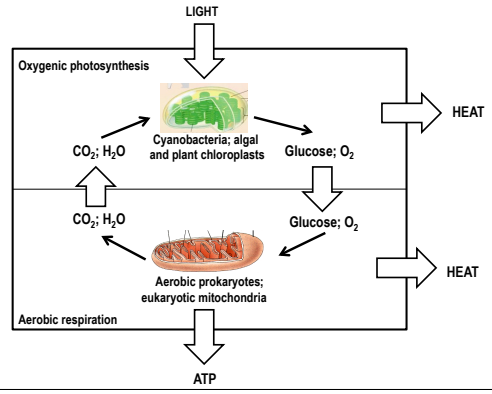

Cyanobacteria; algal and plant chloroplasts


Aerobic prokaryotes; eukaryotic mitochondria

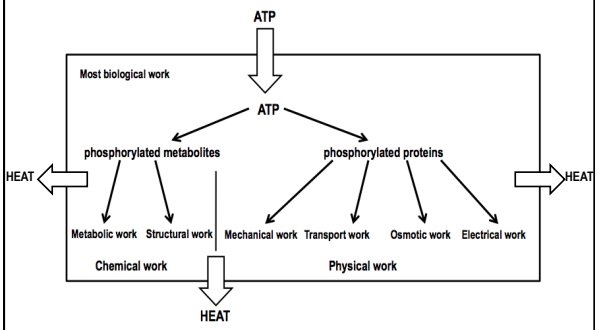
Common forms of cellular work:

Terms	Explanations (do not write onto chart)
heat	
phosphorylated metabolites	high-energy intermediates
electrical work	membrane potentials, action potentials
structural work	polymerization – e.g., chitin, cellulose
phosphorylated proteins	often resulting in conformational changes
osmotic work	hydroregulation, transport, excretion
ATP	
transport work	nutrient uptake, excretion
metabolic work	synthesis – e.g., amino acids, lipids, sugars
mechanical work	motor proteins – e.g., myosin, dynein

Energy flows in the biological world



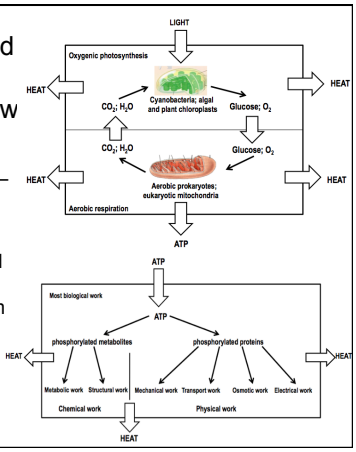
Energy flows in the biological world



General features and operating rules of biological energy flow

1. Small group discussion – identify general features and operating rules.

2. Write down features and rules in your in-class worksheet, and share them in class discussion



We'll discuss your rules in Monday's class