4-Laws of thermodynamics

What We'll cover:

Review: producers and consumers and new terms: autotrophs and heterotrophs
Review: how these processes relate to food: catabolism, and building up big molecules: anabolism
Review: what organelles are involved in energy processing in eukaryotic cells
What energy is and the two states it comes in (kinetic/ potential)
First 2 laws of Thermodynamics:
Energy cannot be created or destroyed (can change forms)
Entropy increases
Different FORMS of energy (chemical, mechanical, heat)
How disorder increases in the universe
We get chemical energy from FOOD! (breaking down big chemicals into little chemicals)
We use chemical energy by doing nothing and exercising (making big chemicals from little chemicals requires energy)
Enzymes

Review

Day 1: producers and consumers

Examples of producers: what do they produce? Are they really working to make food for everyone else? Really they are self-feeders: **autotrophs.** (auto=self, like in auto immune diseases; troph means to feed)
Consumers: examples? What is it that they consume, and what purpose does it serve for them? These things have to eat other things: **heterotrophs.**

Day 2: Food

What are we getting from the food we eat? Sometimes it is about the atoms/chemicals themselves that we use to build us up, but also, when we carry out **catabolic** reactions (such as? What do we break carbohydrates down into?), this releases energy stored in chemical bonds between atoms. We need that energy to stay alive.
Therefore, making large biological molecules, like autotrophs do, is **anabolic** and requires energy. What is the source of energy for autotrophs?

Day 3: Cells

What organelles inside cells carry out these processes?
What organelles do plant cells have? Animal cells?
(Do prokaryotic cells, that don't have organelles carry out these processes?)

Energy

Energy is the capacity to do work (or cause change)

Energy can be in 2 states

Potential energy is stored energy. Examples: a rock at the top of a hill, or a donut
Kinetic energy is the energy of motion—it is currently doing work. Examples: a rock rolling down a hill, us running (using the calories in a donut)

First Law of Thermodynamics: Energy cannot be created or destroyed!

First law of thermodynamics (above)
BUT—energy can change FORMS

engery can change between 3 forms: and heat is a byproduct

Chemical: energy is stored in chemical bonds (example: donut, gasoline in car)

Mechanical: energy of movement (example: car moving)

Radiant: heat (example: if your radiator isn't working, your engine will overheat

Put gas (chemical) in your car, so your car can move (mechanical) but you lose A TON (like 75%?) of that chemical energy to radiant energy (heat).

(Energy that is useful = free energy)

Second law of thermodynamics: Entropy increases

Heat is chaotic and isn't very useful energy, and its hard to harness

Heat is hard to do anything with, so although you cannot destroy energy, you lose useful energy
Heat is the chaotic movement of molecules
The second law of thermodynamics is: chaos (also called **entropy)** increases!

So chemical reactions that increase disorder (entropy) "want" to happen and are **spontaneous**

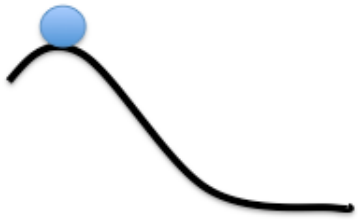
How are oxygen and carbon dioxide involved?

ENZYMES: PROTEINS IN THE CELL THAT DO THINGS

Almost all enzymes are proteins
Names end in –ase (lactase, amylase)

$C_6H_{12}O_6 + 6O_2 \rightarrow$energy + $6CO_2 + 6H_2O$

7 molecules→ 12 molecules (more disorganized)



energy stored in bonds vs. progression of the reaction

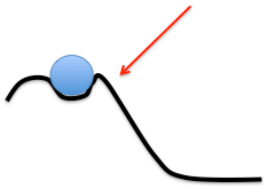
reactions want to do this way (chaos increases!)

BUT…Marshmallow burning….

It doesn't mean that this reaction will happen right away!

ACTIVATION ENERGY:

Some energy needs to be put into the reaction to get it going:



Enzymes LOWER THE ACTIVATION ENERGY!! Make the reactions happen more quickly!!

HOW ENZYMES WORK:

INDUCED FIT MODEL:

Enzyme
Substrate (in reality MUCH smaller, is the reactant in a chemical reaction)
Active site

Substrate "fits" into the active site of the enzyme—and then the two fit together (a bit like how your hand changes shape when you shake hands)

The active site "fits" the substrate in shape and polarity/charge

Other substrates won't fit
One enzyme – one substrate!
Enzymes remain unchanged by a reaction: can go on to do many reactions