Energy transformations in living things

Chemical Equations
Breaking Bonds
Calories
Combustion/Food Energy

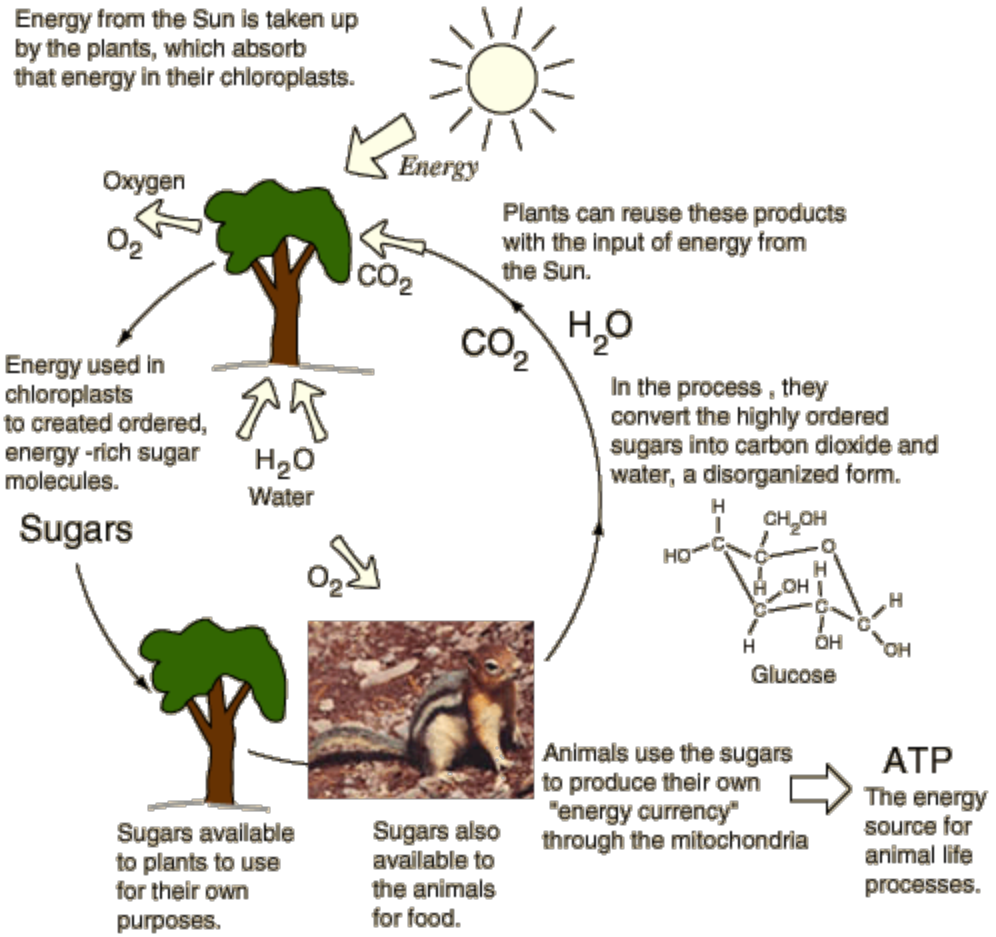
Energy Transformations

- Energy cannot be created or destroyed, only changed from one form to another.
- Energy is any force that results any kind of movement .

Types of energy

- kinetic
- mechanical
- chemical
- electrical
- light
- heat
- nuclear
- Sound

Light to chemical conversions in plant cells



Calorimeter and You

Calorimeters really burn me up!

What you need to know:

- Energy causes change.
- Energy ability to transfer heat
- Explain how the calorimeter helped you to understand how energy causes change in engines and in your body.
- Potential energyKinetic energy
- Heat energy Reactants
- Light energyProducts
- Energy transfer
- Chemical reactionscalorie
- CombustionCalorie
- Respiration
- Enzymes

Pecans

- Stored food (**potential energy**) for the pecan tree.
- Stored food (**potential energy**) for animals.

Pecans

Plants like the Pecan Tree use light energy from the sun to make food(carbohydrates, lipids, protein)

light/chlorophyll

$6CO_2$ + $6H_2O$ → $C_6H_{12}O_6$ + $6O_2$

Carbon Dioxide — **water** — **sugar, fats, protein** — **oxygen**

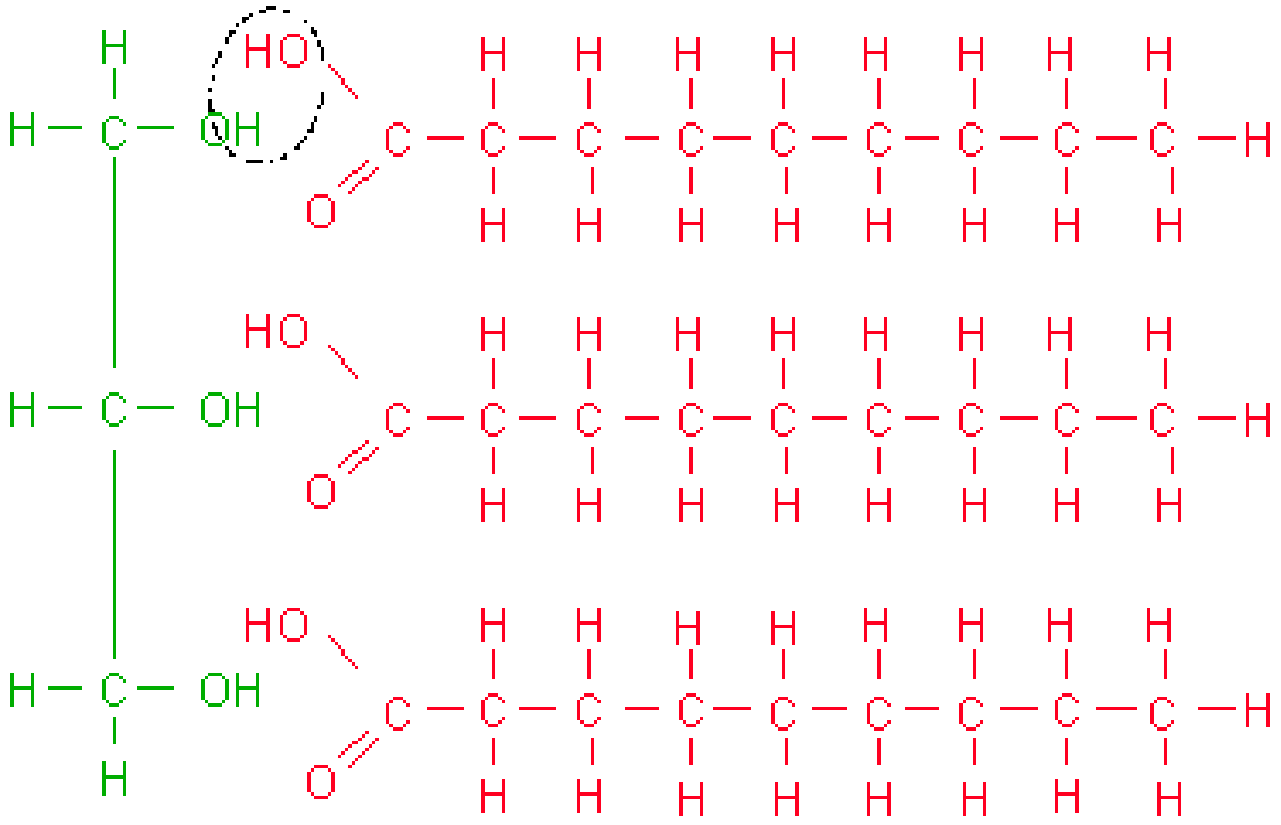
Pecan = Tree Seed

The parent tree sends the embryo in the seed off with a good supply of food energy to help the seed grow before it gets leaves

Energy

- Energy + Matter = Change
- PLANTS CONVERT LIGHT ENERGY TO CHEMICAL during PHOTOSYNTHESIS
- Sun + Carbon dioxide + Water = Stored Chemical Energy(in bonds of lipids, proteins, carbs)

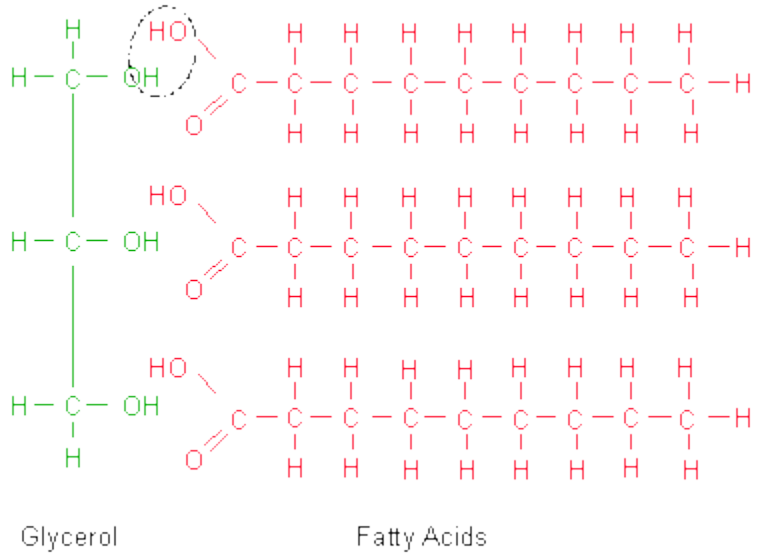
Fats = stored energy



Glycerol

Fatty Acids

Atoms connected by bonds = stored chemical energy

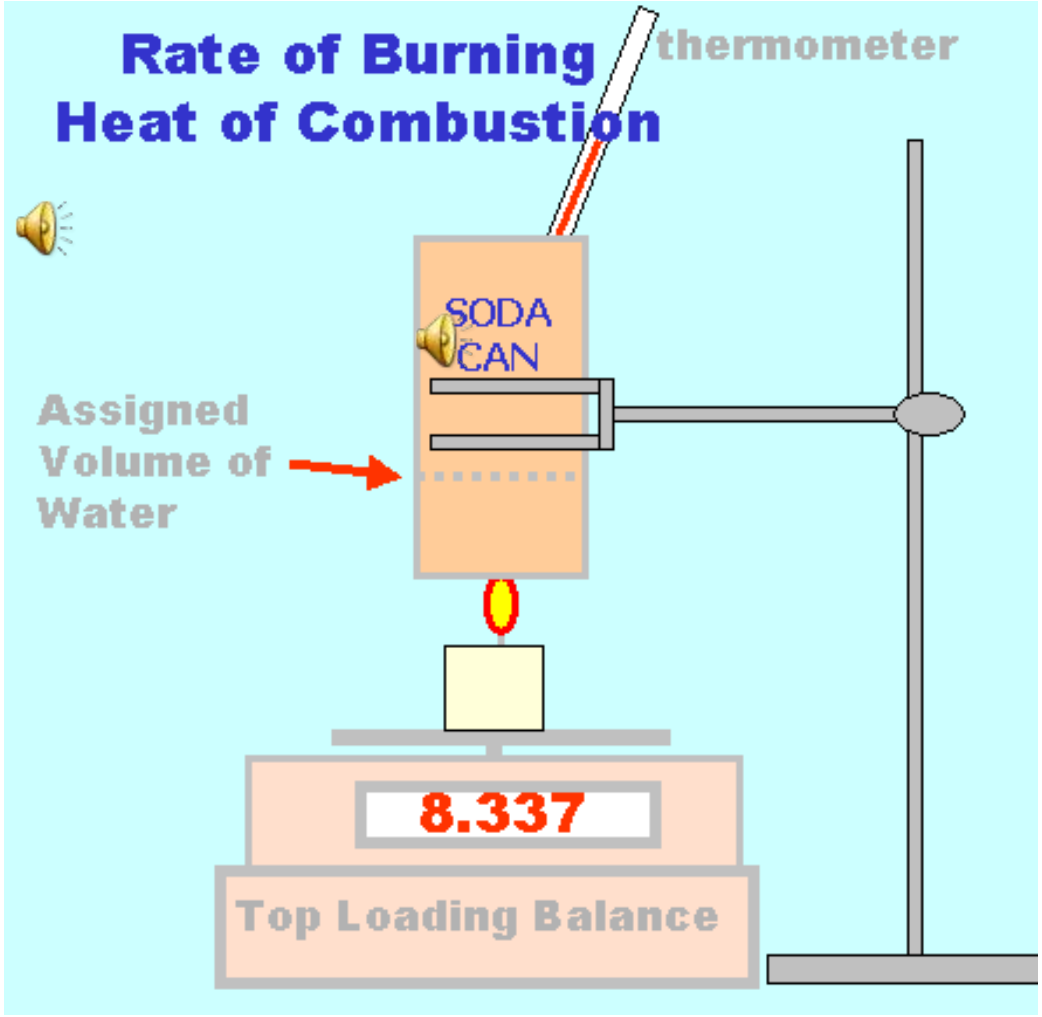


Glycerol Fatty Acids

How can you determine how much stored potential chemical energy is in the nut?

- RELEASE THE CHEMICAL ENERGY STORED IN THE BONDS BY BREAKING THESE BONDS DURING A CHEMICAL REACTION- CONVERTS TO HEAT AND LIGHT ENERGY
- MEASURE THE HEAT GIVEN OFF

Calorimeter!



HOW DO WE MEASURE THE HEAT GIVEN OFF?

- IN CALORIES
- One calorie is the amount of energy need to raise one gram of water by one degree Celsius.

- Food Calories = 1/1000 of calories

(calories on packages are really Kilocalories and have a capital C) divide calories by 1000 to get this.

How to calculate calories?

calories = (final temp- start temp) x amount of water(g) x 1cal/g C

=(60 C -- 20 C) x 100 g x 1cal/g C

= (40 C) X 100 g x 1cal/g C (cancel units)

= 4000 cal

Change to kilocalories or (Calories)- divide by 1000

Therefore 4000 cal = 4 kilocalories or 4 Calories(this is on packages)

Why calculate Calories per gram?

DO YOU EXPECT DIFFERENT AMOUNTS OF FOOD TO HAVE DIFFERENT CALORIES?

YES..since LARGER NUTS HAVE MORE MASS = more atoms which means more bonds between atoms to break = more heat energy released

MORE BONDS TO BREAK= MORE ENERGY(HEAT)=MORE CALORIES

SINCE WE DID MORE THAN ONE TRIAL HOW WILL WE COME UP WITH AN AVERAGE IF THE MASSES OF THE FOODS ARE DIFFERENT

WE HAVE TO:

CALCULATE THE CALORIES PER ONE GRAM BY DIVIDING THE CALORIES BY THE MASS CONSUMED IN THE COMBUSTION REACTION

Calories per gram= Calories per nut /mass of the nut consumed

Example on how to calculate calories per gram

- Kilocalories(step 8)

  DIVIDED BY

  MASS CONSUMED (Step 3)

$$\frac{\text{Kilocalories}}{\text{mass consumed}} = \text{Calories per 1 gram}$$

Finding Average of Calories per gram

- Average trial 1 and trial 2
- Step 9 $\frac{\text{trial 1Cal/g + trail 2 Cal/g}}{2}$

___

FINDING RANGE

Trail 1 Cal/g - Trail 2 Cal/g I

DATA TABLE FOR CALORIE LAB

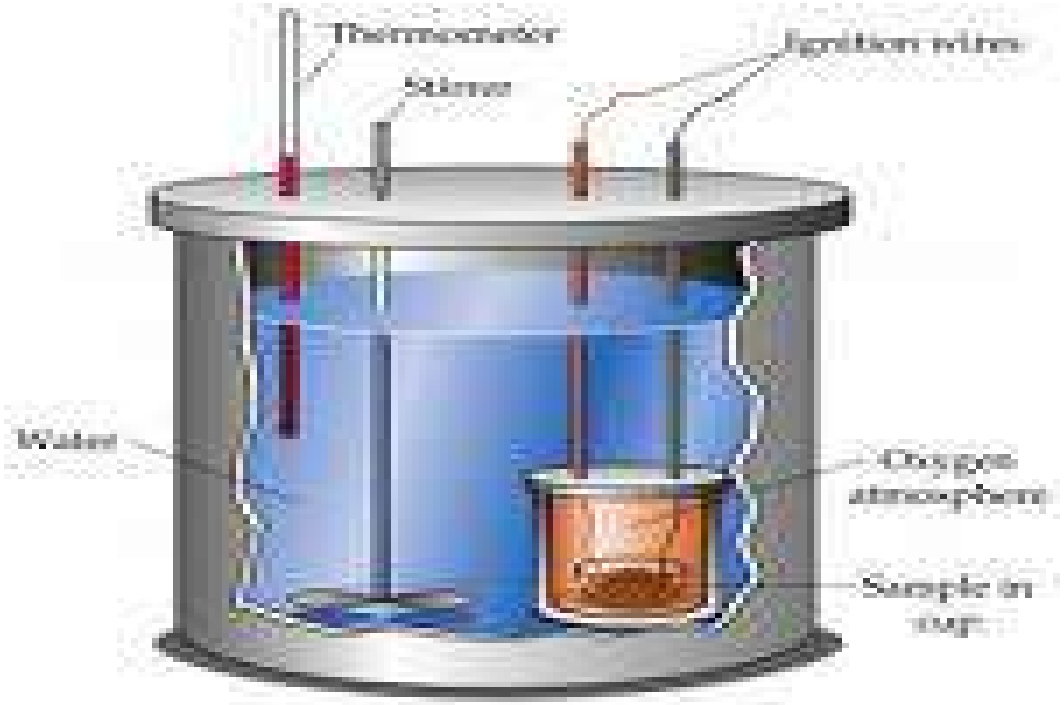
- Calorie lab data table.doc

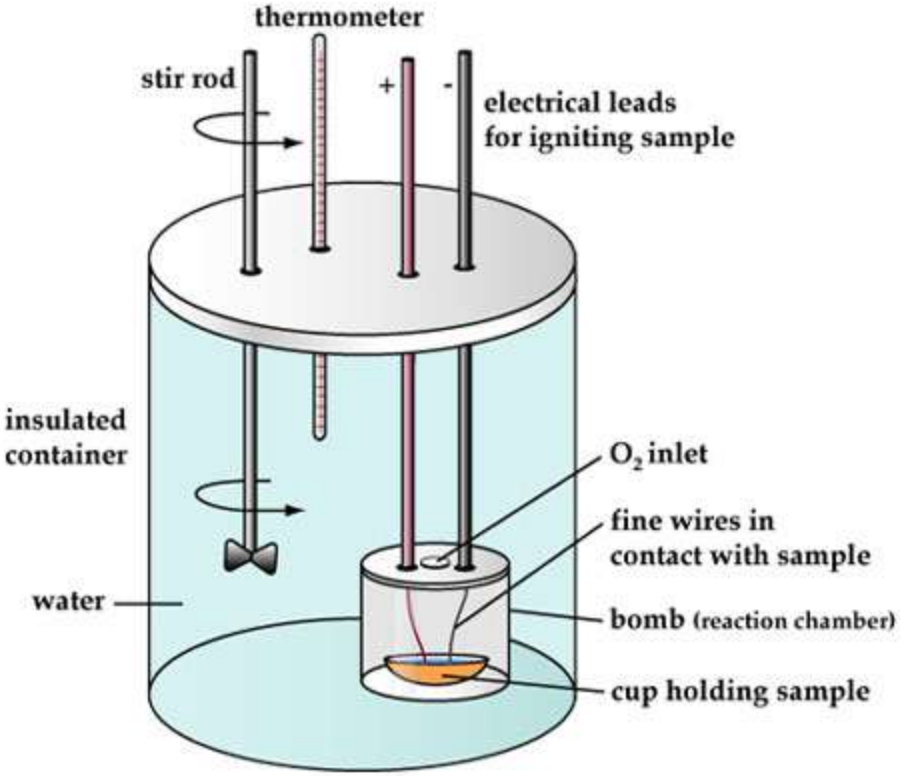
When bonds are broken

Heat is released =Kinetic energy
Light released = kinetic energy

We measure the heat transfer in calories by how much the temperature of water rise

BOMB CALORIMETER




thermometer
stir rod
+
-
electrical leads
for igniting sample
insulated
container
O_2 inlet
fine wires in
contact with sample
water
bomb (reaction chamber)
cup holding sample

FINDING PERCENT ERROR

$$\% \text{ ERROR} = \frac{\text{ACCEPTED-EXPERIMENT}}{\text{ACCEPTED}}$$

ACCEPTED IS THE CALORIES ON PACKAGE

EXPERIMENTAL IS THE CALORIES FOUND DURING THE EXPERIMENT

What is the difference between the EXPERIMENTAL AND ACCEPTED SET UPS?

- HEAT LOSS DIFFERENCES

- INCOMPLETE AND COMPLETE COMBUSTION DIFFERENCES

Energy is needed to

- To stay warm

Energy is needed for life to…

How do living things use energy

- Move around- mechanical energy
- Keep warm- heat energy
- Reproduce- various energies
- Move molecules- kinetic energy
- Nerve impulse- electric and chemical
- Bioilluminesence- light
- See- light, chemical, electrical

Chemical energy is stored in food.

Cells get the energy stored in food through a series of **Chemical Reactions called REPSPIRATION**

Fire is evidence of a **chemical reaction**!

WHAT ARE CHEMICAL REACTIONS?

- http://www.usoe.k12.ut.us/curr/science/sciber00/8th/matter/sciber/chemtype.htm

REACTANTS-→ PRODUCTS

How is burning a nut is …

A release of chemical energy from the sun??

Combustion is a type of chemcial reaction that is EXOTHERMIC

- EXOTHERMIC MEANS THAT ENERGY IS GIVEN OFF WHEN ATOMS BREAK BONDS AND REBOND WITH OTHER ATOMS

- http://mae.ucdavis.edu/sdsu/thermo/testhome/vtAnimations/animations/chapter12/reaction/index.html

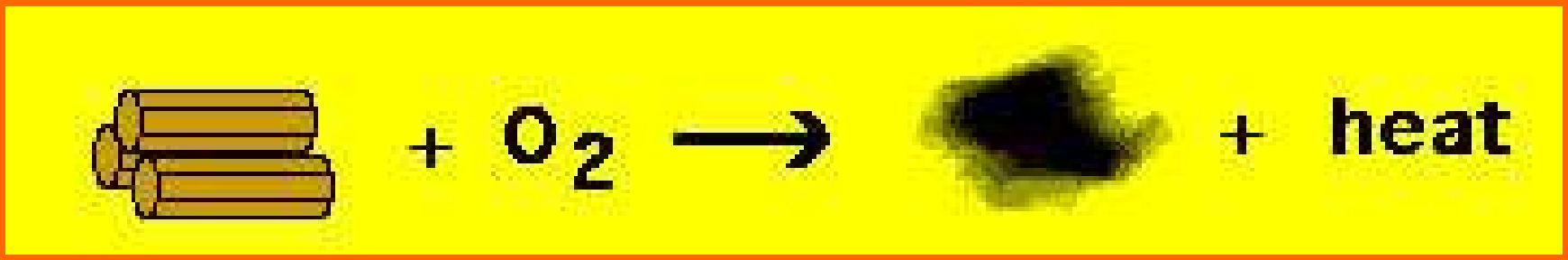
What type of energy is transformed during this combustion reaction?

CHEMICAL ENERGY STORED IN THE BONDS BETWEEN THE ATOMS IN THE FOOD IS CHANGED INTO HEAT AND LIGHT ENERGY

When these bonds are broken this amount of heat energy is released

- **Average bond energies**
- **kcal/mole**
- C-H 98
- O-H 110
- C-C 80
- C-O 78
- H-H 103
- C-N 65
- O=O 116 (2 x 58)
- C=O 187* (2 x 93.5)
- C=C 145 (2 x 72.5)(* as found in CO2)

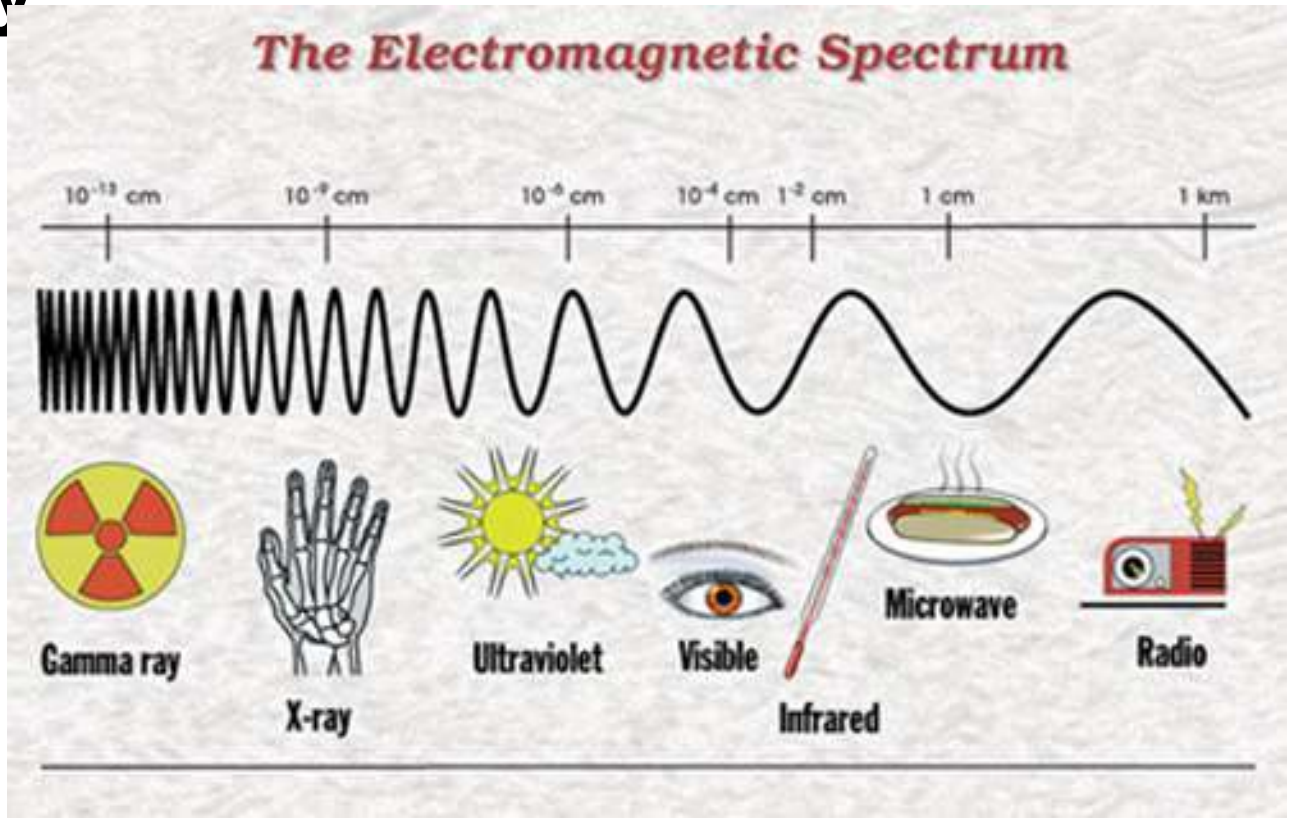
Combustion reactions always involve molecular oxygen O2. Anytime anything burns (in the usual sense), it is a combustion reaction. Combustion reactions are almost always exothermic (i.e., they give off heat). For example when wood burns, it must do so in the presence of O2 and a lot of heat is produced:



During the combustion reaction Chemical energy stored in the bonds between the atoms is released as…

Combustion releases

Light Energy



Combustion releases

- **Heat**

So why aren’t your cells are on FIRE!!!

“Mickfissle, I’m Hot”

Why do you sweat and get hot when you exercise?

- **Glucose + Oxygen = Carbon Dioxide + Water + Energy**
- **$C_6H_{12}O_6+6O_2=6CO_2+6H_2O+Energy$**

What type of ENERGY is GIVEN OFF?

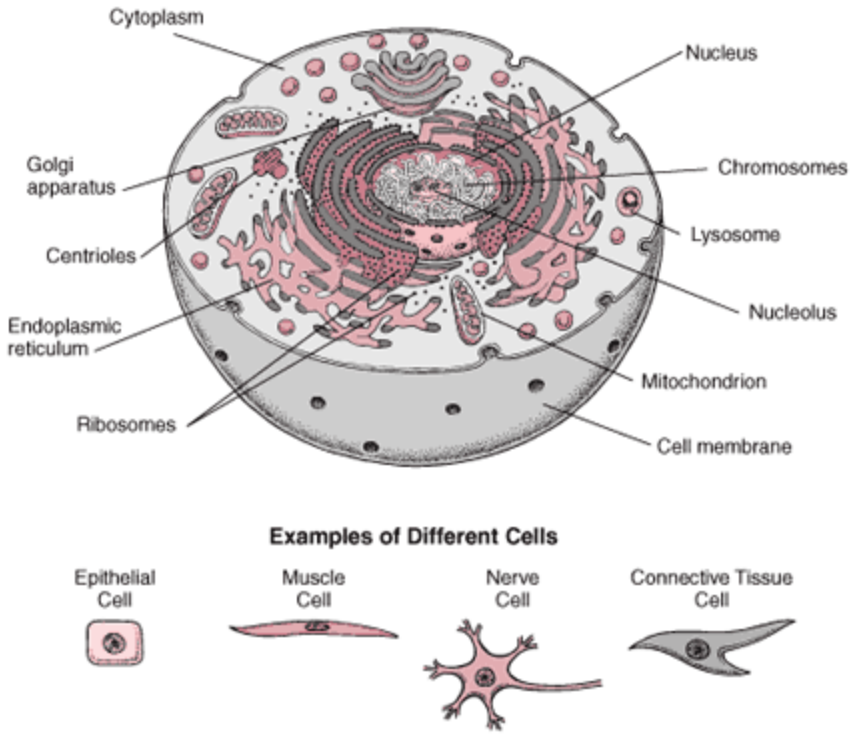
WHAT TYPE OF ENERGY DID THIS GET CONVERTED FROM?

You are burning calories in the food you ate just like the_____

- CALORIMETER COMBUSTION REACTION

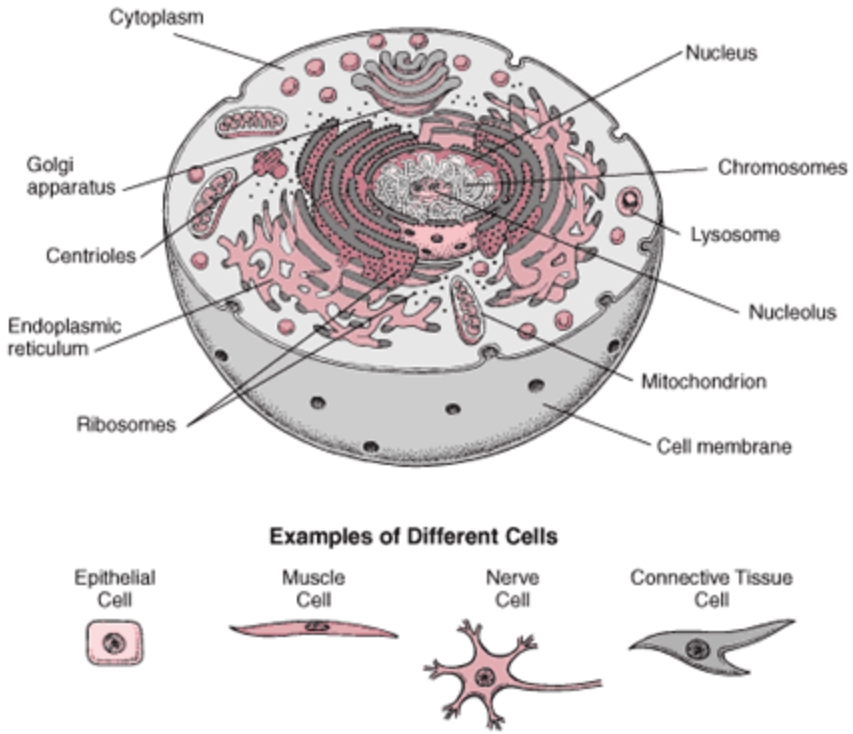
HOW IS COMBUSTION LIKE RESPIRATION?

Enzymes help your cells to burn energy in little steps



Your cells are like little engines

Cells eat glucose or blood sugar.



Respiration

- Cells converting the chemical energy in food to other forms of energy needed by the cells
- These other forms of energy are:

Chemical – stored in ATP

Mechanical- moves molecules ex. Actin/myosin fibers slide during muscle contraction

Heat- why we are 98.6°F or 37°C

Try this….

- Gather:
- straw
- bromothymol blue
- Flask

How do we know that carbon dioxide is given off?

- Blow into flask
- Note any changes

Evidence that a chemical reaction occurred

- Color change
- Energy given off(exothermic) ex heat or light
- Energy taken in (endothermic) ex. Area gets cold due to heat taken in(cold pack)

Aerobic Cellular Respiration

Organic compound + O_2 → CO_2 + H_2O + energy

Lipids

Proteins

Carbohydrates

Where does this happen?

In cell's cytoplasm and finishes in mitochondria.

Law of Conservation of Mass

- Mass can not be created NOR destroyed.

So where did the mass in the nut go in the calorimeter experiment?

GIVEN OFF AS:

THIS IS THE MASS CONSUMED

CARBON DIOXIDE AND WATER

gases in the air

- Where does the nut go when you eat it?

Where does the energy stored in food go after we eat it?

Is it burned in your cells?

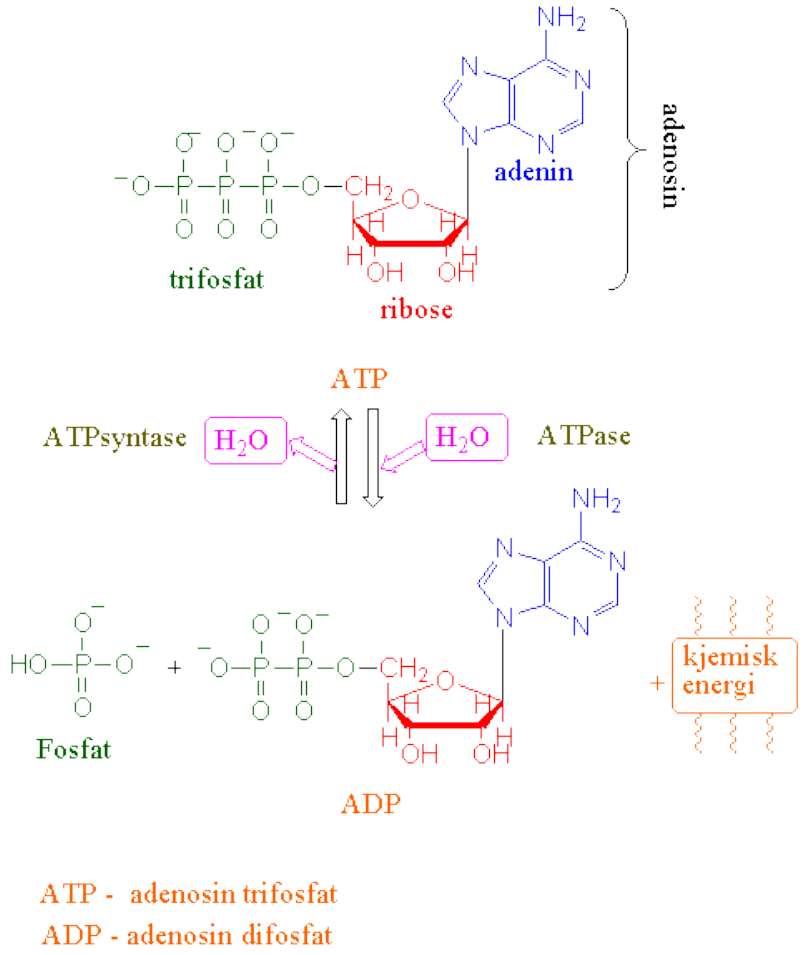
NO!!!!

IT IS CONVERTED TO HEAT TO KEEP US WARM

AND IS STORED IN ATP TO RUN OUR CELLS

ATP

- In living cells, energy is stored as molecules of ATP, adenosine triphosphate. When the energy is used, one of the phosphates attached to ATP is released, giving ADP, adenosine diphosphate.
- The 3 phosphates each have a negative charge, and so they repel each other. When the bond holding them together is broken, the phosphates fly apart, like a spring being released. The cell can use this energy in many different ways.



What do engines eat?

Engines eat broken down plants

What about the calorimeter?

- How did the calorimeter show food is stored potential energy?
- How did the calorimeter show that a chemical reaction releases energy?
- Does the sun have any connection to this lab?
- Why aren’t our cells on fire?

What about the food web?

CALORIE LAB DISCUSSION

- CALORIE LAB NOTES.doc