

Energy transformations in living things

Chemical Equations

Breaking Bonds

Calories

Combustion/Food Energy

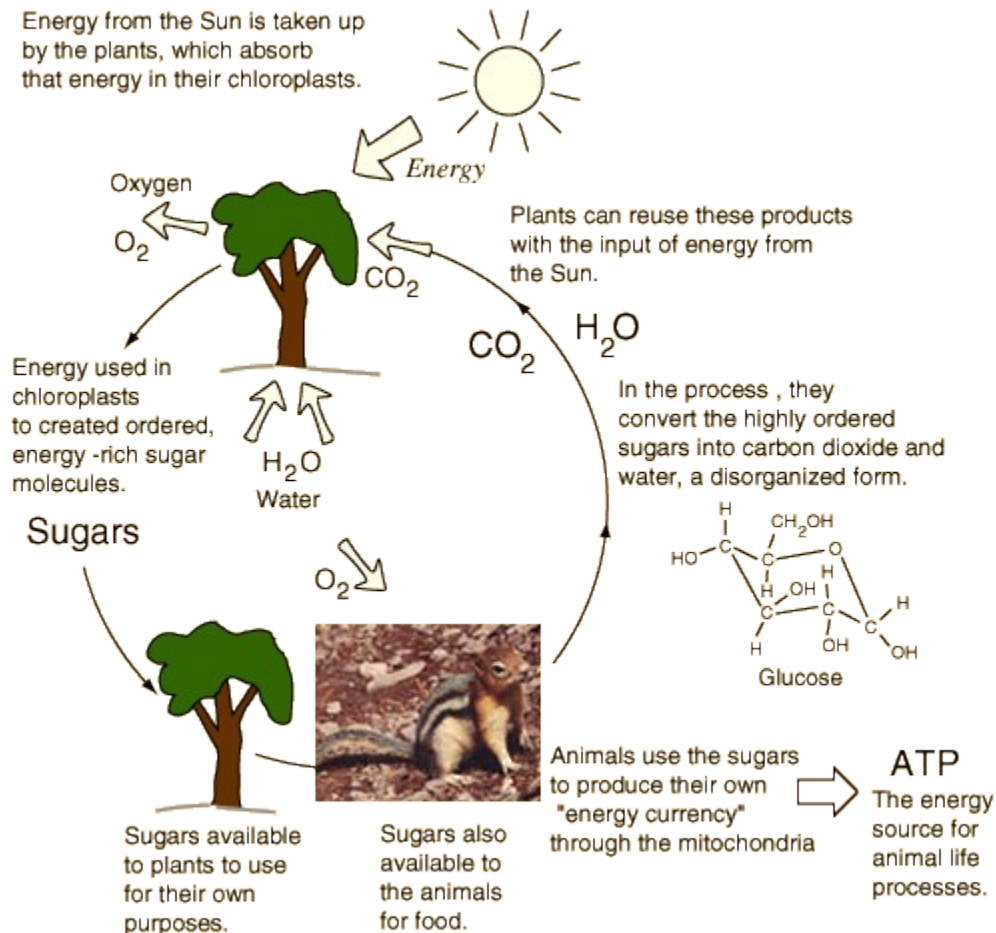
Energy Transformations

- 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 energy Kinetic energy
- Heat energy Reactants
- Light energy Products
- Energy transfer
- Chemical reactions calorie
- Combustion Calorie
- Respiration
- Enzymes

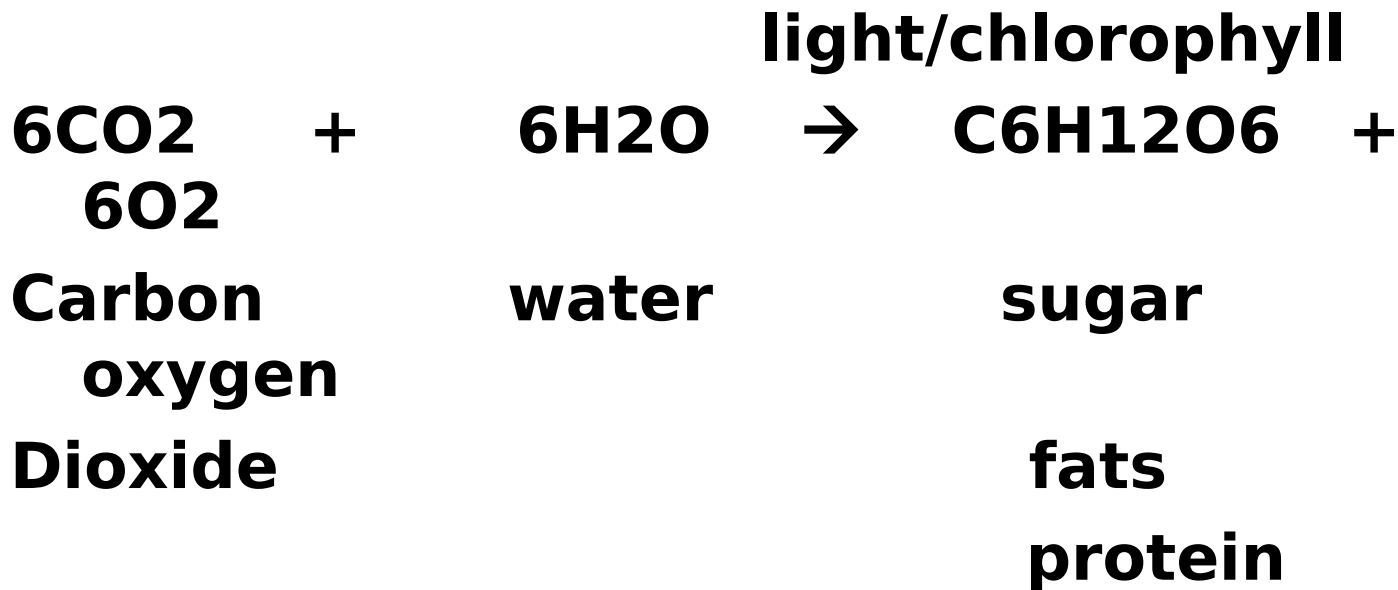
Pecans

- 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)



I recall — tree seed

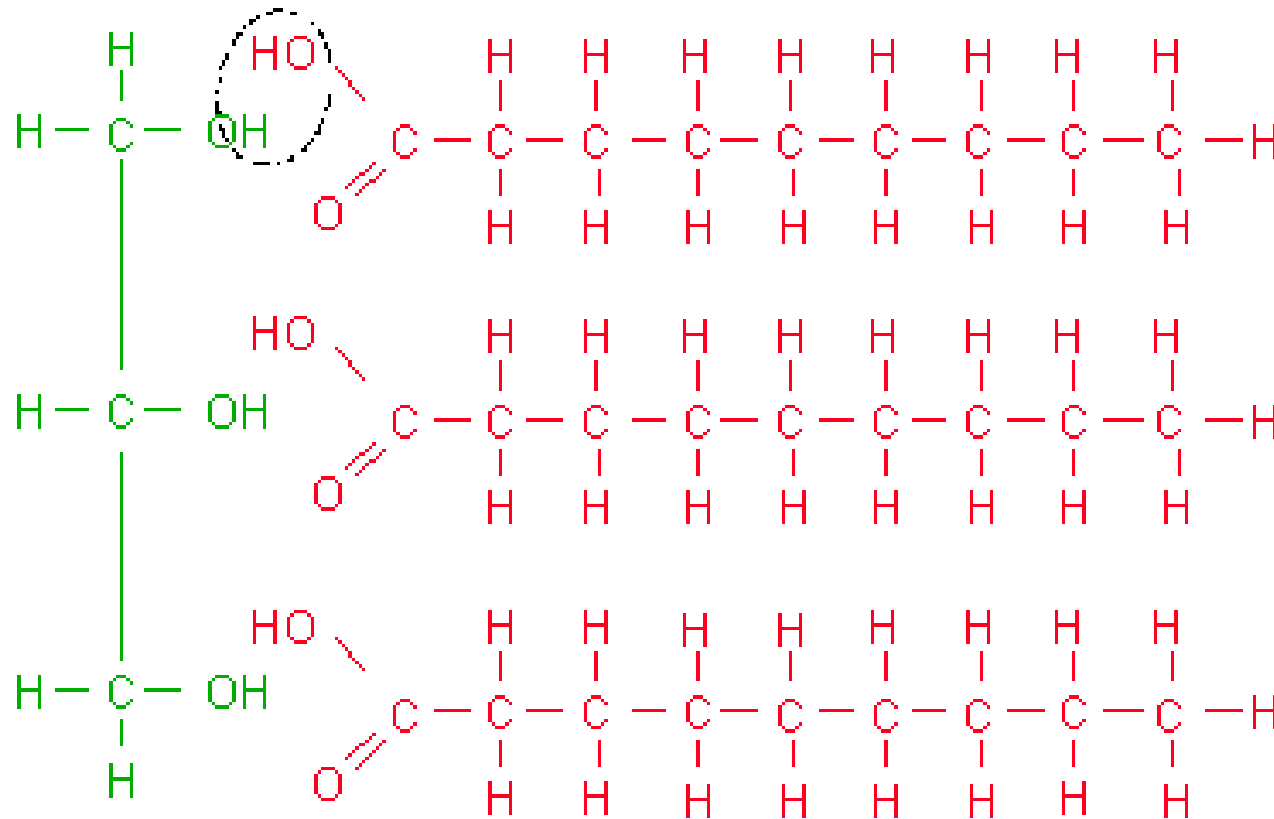
The parent tree sends the embryo in the seed off with a good supply of food energy to help the seed grow before it gets leaves



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)

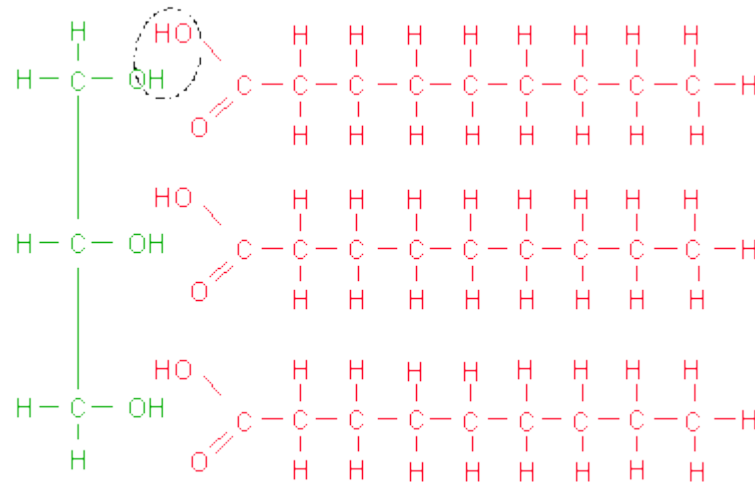
Fats = stored energy



Glycerol

Fatty Acids

Atoms connected by bonds = stored chemical energy



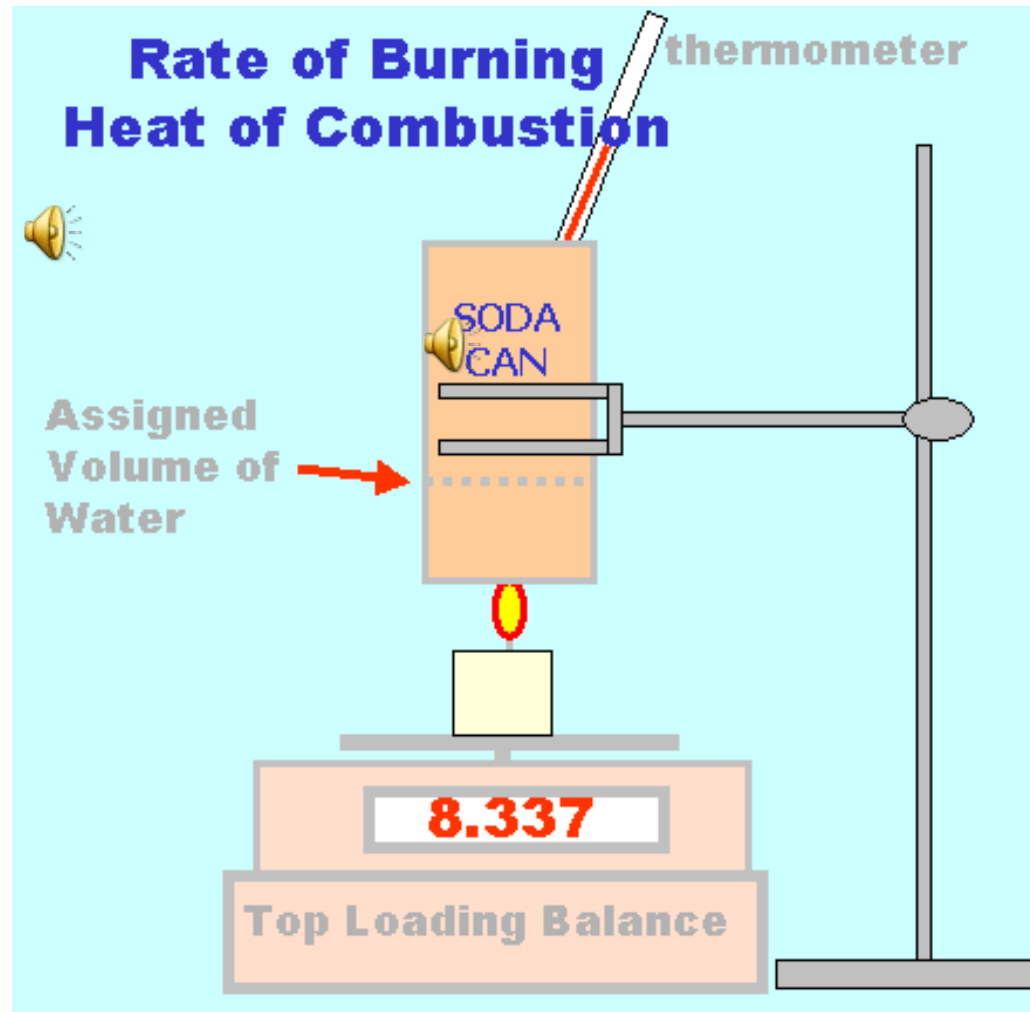
Glycerol

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?

$$\begin{aligned}\text{calories} &= (\text{final temp} - \text{start temp}) \times \text{amount of water(g)} \times \\ &\quad 1\text{cal/g } ^\circ\text{C} \\ &= (60^\circ\text{C} - 20^\circ\text{C}) \times 100\text{ g} \times 1\text{cal/g } ^\circ\text{C} \\ &= (40^\circ\text{C}) \times 100\text{ g} \times 1\text{cal/g } ^\circ\text{C} \quad (\text{cancel units}) \\ &= 4000\text{ cal}\end{aligned}$$

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)

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

Finding Average of Calories per gram

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

FINDING RANGE

Trail 1 Cal/g - Trail 2 Cal/g

DATA TABLE FOR CALORIE LAB

- [Calorie lab data table.doc](#)

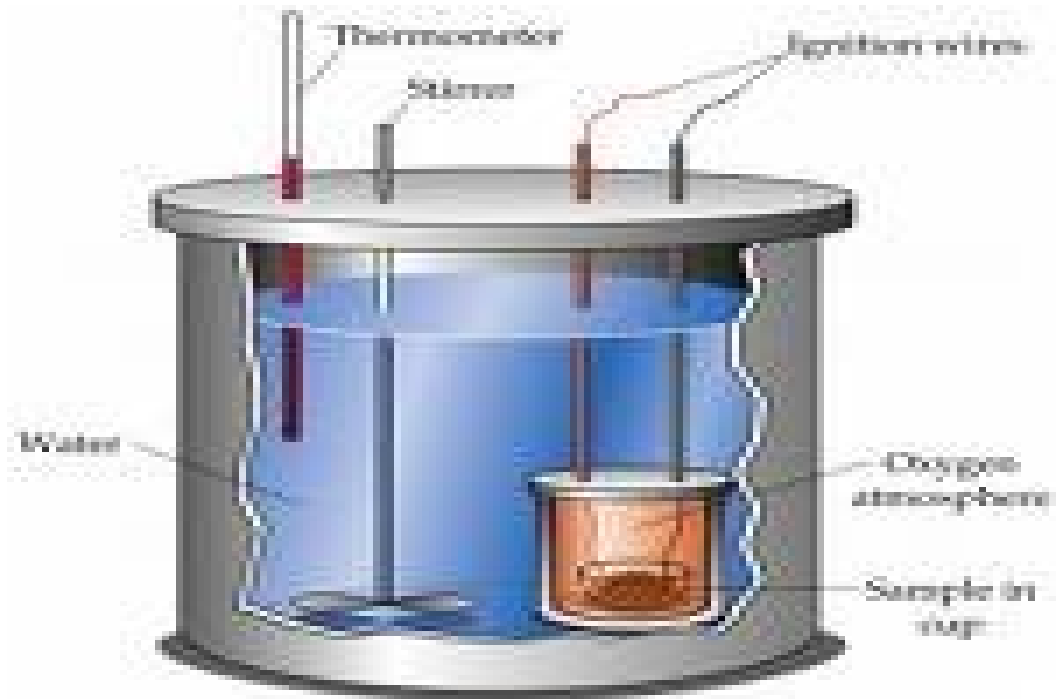
When bonds are broken

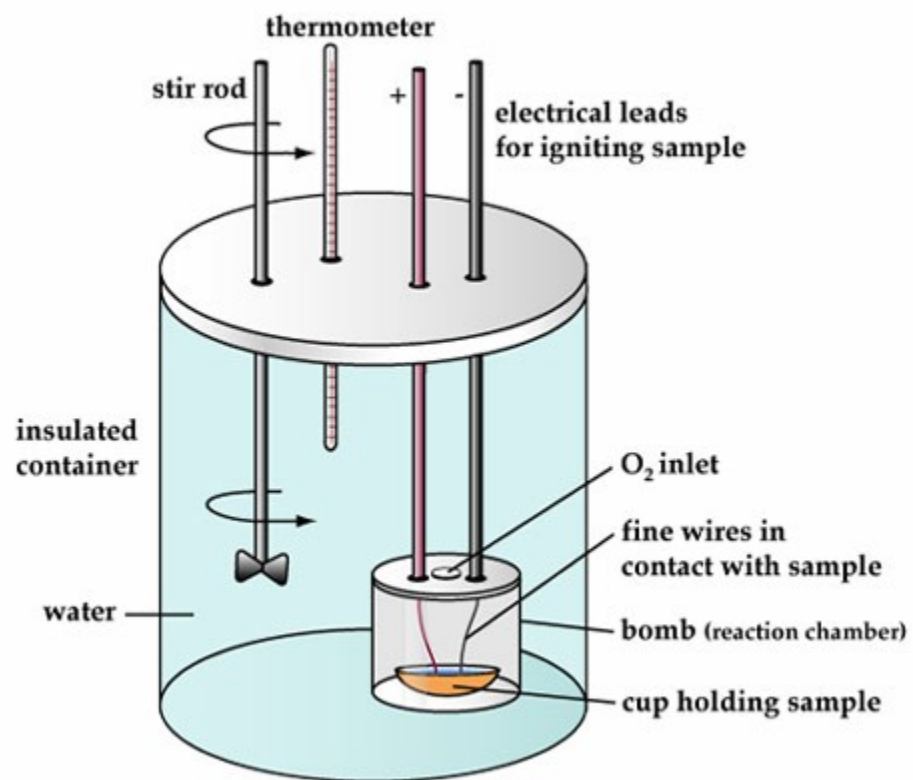


Heat is released = Kinetic energy
Light released = kinetic energy

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

BOMB CALORIMETER





FINDING PERCENT ERROR

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

ACCEPTED IS THE CALORIES ON
PACKAGE

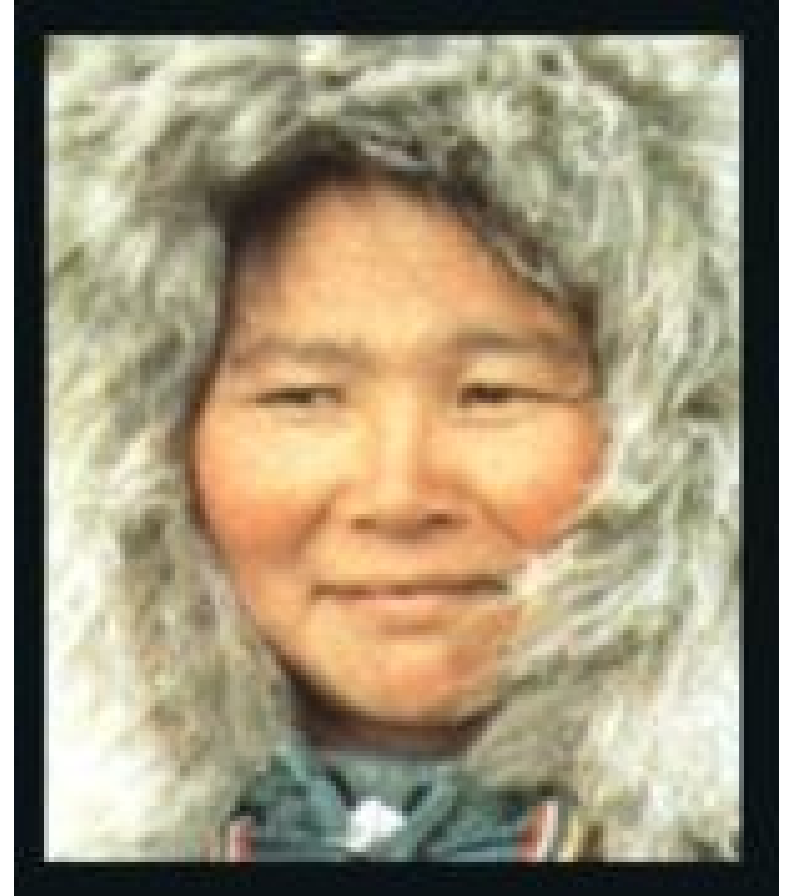
EXPERIMENTAL IS THE CALORIES
FOUND DURING THE EXPERIMENT

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

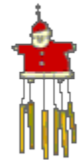


Energy is needed for life to...



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

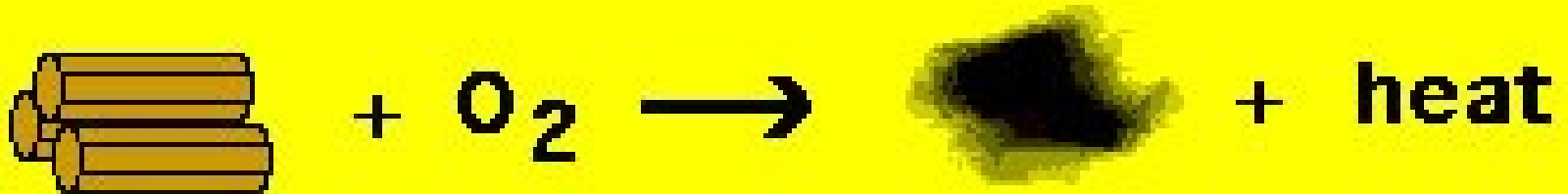
- **Average bond energies**

- **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:

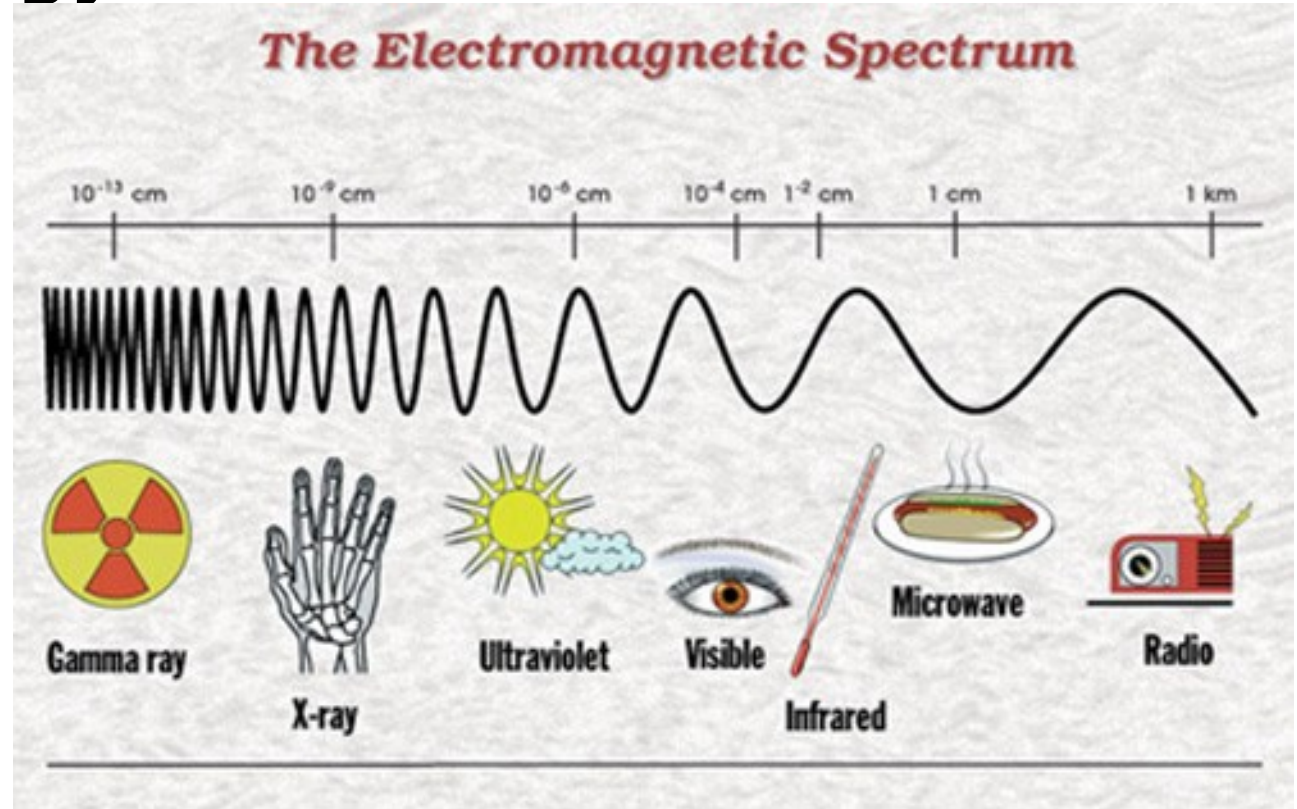


**During the combustion
reaction**

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**
- **$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O + \text{Energy}$**

What type of ENERGY is GIVEN OFF?

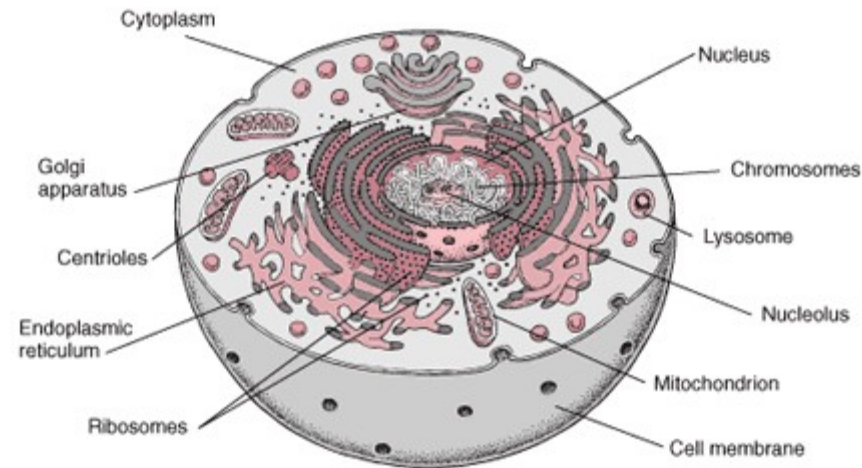
WHAT TYPE OF ENERGY DID THIS GET CONVERTED FROM?

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



Examples of Different Cells

Epithelial Cell



Muscle Cell



Nerve Cell



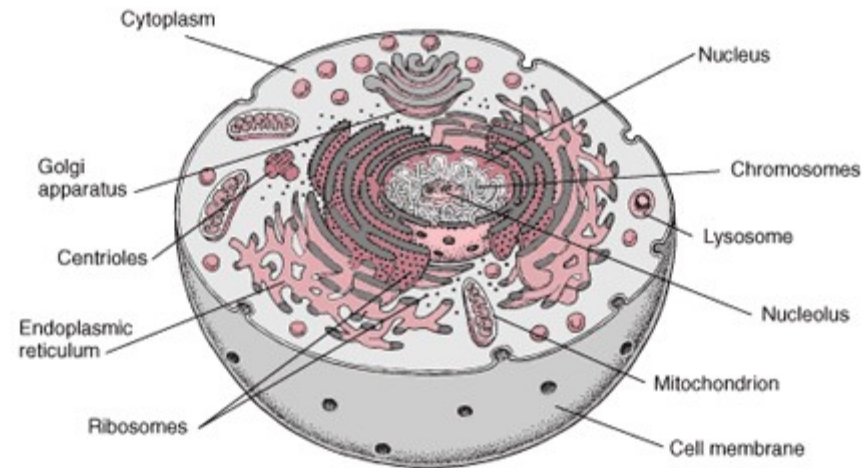
Connective Tissue Cell



Your cells are like little engines



Cells eat glucose or blood sugar.



Examples of Different Cells

Epithelial Cell



Muscle Cell



Nerve Cell



Connective Tissue Cell



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 + O₂ → CO₂ + H₂O +
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?

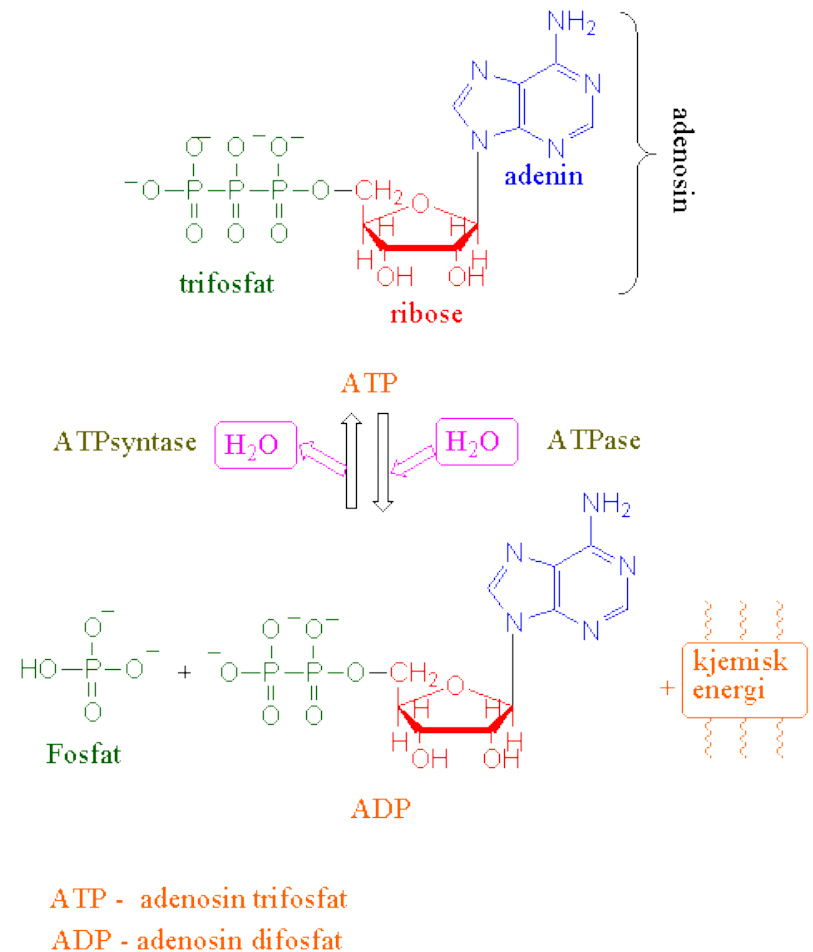
NO!!!!

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](#)