A pair of hands is shown holding a small, realistic globe of the Earth. The globe is centered on the Americas, showing North and South America in green and yellow, surrounded by blue oceans and white clouds. The hands are positioned at the bottom and sides of the globe, with fingers gently gripping it. The background is black, and the entire image is framed by a bright green border. The text "The Chemistry of Life" is overlaid in white, bold, sans-serif font across the middle of the globe.

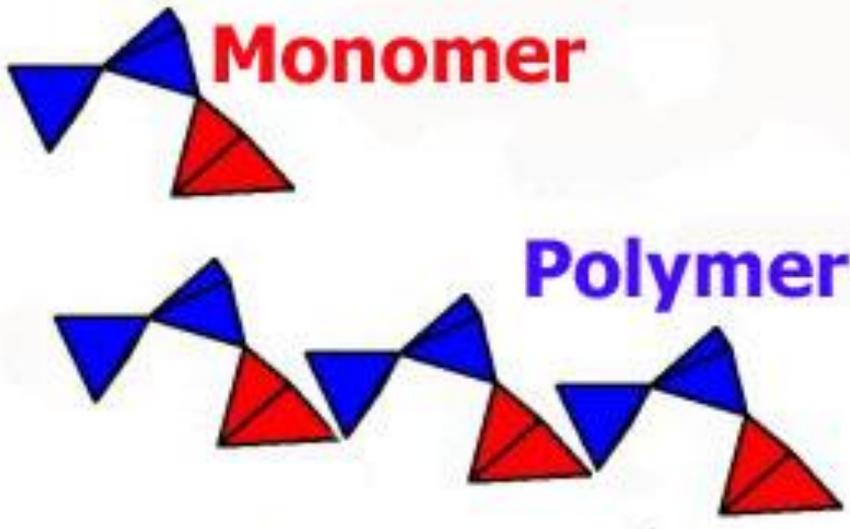
# The Chemistry of Life

### Focus Questions:

1. What elements make up most of the mass of living organisms on Earth?
2. What are the major molecules, small and large, that make up organisms and control chemical reactions in the organisms?

# What you already know...

In a previous activity you learned that plants, animals, and other living things make thousands of giant polymer molecules from small carbon-based monomers.



Giant polymer molecules are made from smaller repeating monomers.

All living things are made up of a great variety of different molecules. Some are small like H<sub>2</sub>O and salt and others are massive polymers made up of thousands of atoms.

### The Elements of Life

Periodic Table of the Elements

1 H	2 He											13 B	14 C	15 N	16 O	17 F	18 Ne														
3 Li	4 Be											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar														
11 Na	12 Mg	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar														
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr														
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe														
55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tm	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

Most of the mass on Earth is made up of only 6 elements!

Can you guess which ones?

- Hydrogen
- Carbon
- Nitrogen
- Oxygen
- Phosphorus
- Sulfur

# The Chemistry of Life

## Key Questions:

1. What elements make up most of the mass of living organisms on earth?
2. What are the major molecules, small and large, that make up organisms and control chemical reactions in the organisms?

## Evidence:

1. Most of the mass of all living organisms (animals and plants) on Earth is made up of Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorus, and Sulfur.

**CHNOPS**

Of course, other trace elements are important for plants and animals. Look at the chart of the elements in humans - what other elements are found in the human body?

## Elements in the Human Body

Oxygen	65.0%
Carbon	18.5%
Hydrogen	9.5%
Nitrogen	3.3%
Calcium	1.5%
Phosphorus	1.0%
Potassium	0.4%
Sulfur	0.3%
Sodium	0.2%
Chlorine	0.2%
Magnesium	0.1%

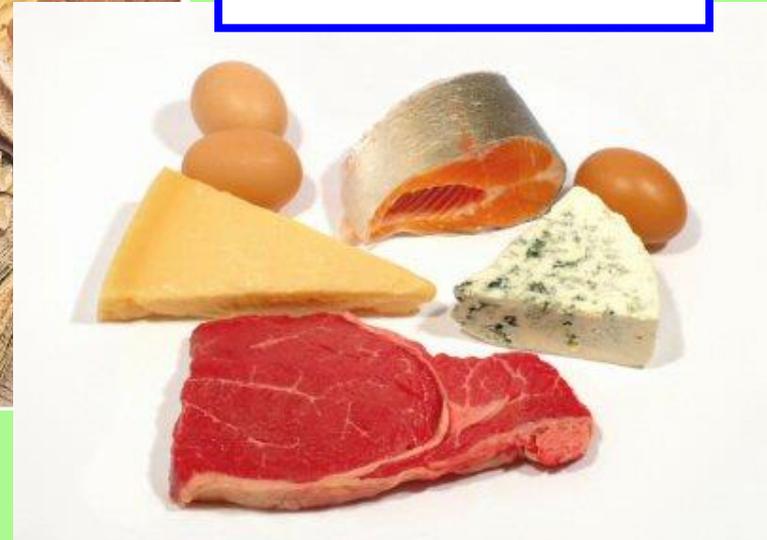
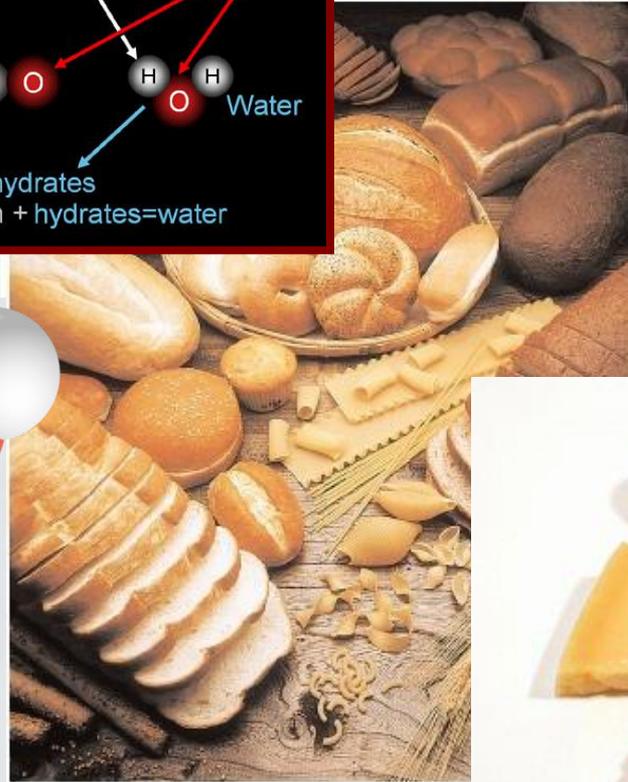
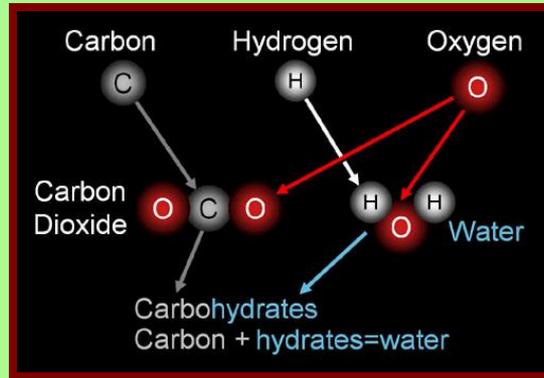


Potassium	0.4%
Sulfur	0.3%
Sodium	0.2%
Chlorine	0.2%
Magnesium	0.1%

Small amounts of other elements and vitamins are also essential for life. For example, the sodium (Na) from salt is used to regulate the movement of water into and out of cells. Vitamins are compounds that are necessary for good health, but are not made in our bodies. Each vitamin performs different, specialized tasks.



# These 6 elements combine to form molecules that are important for life.



# The Chemistry of Life

## Key Questions:

1. What elements make up most of the mass of living organisms on earth?
2. What are the major molecules, small and large, that make up organisms and control chemical reactions in the organisms?

## Evidence:

1. Most of the mass of all living organisms on Earth is made up of these six elements: Oxygen, Carbon, Hydrogen, Nitrogen, Phosphorus, and Sulfur.

**CHNOPS**

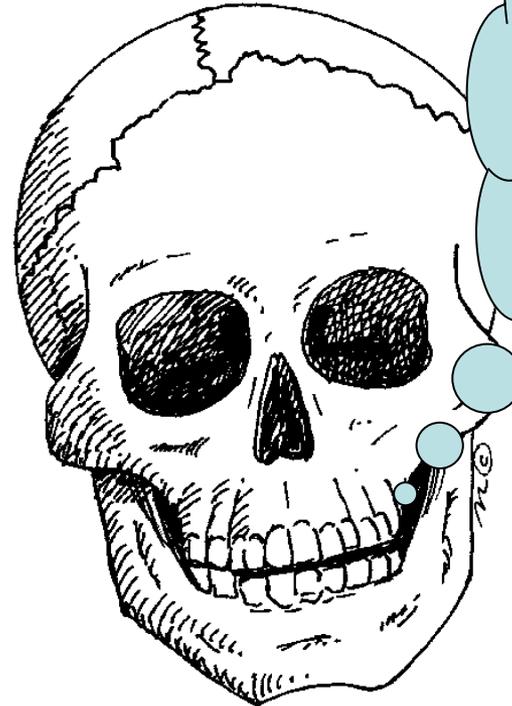
- 2. All molecules that are important for life are made from combinations of these 6 elements (CHNOPS).**
- 3. Small amounts of other elements and vitamins are also essential to life and are obtained from a balanced diet.**

# Water....

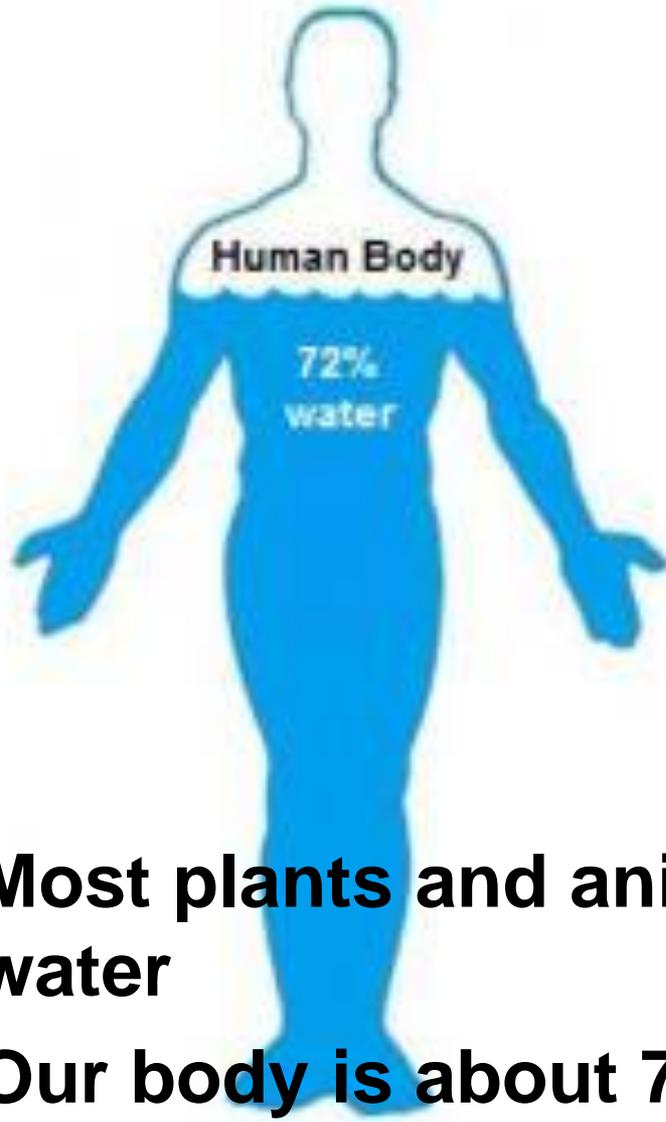
## What would we do without it?



You can survive without food for weeks, you can only survive without water for a few days



GOT  
H<sub>2</sub>O?



Water is  
essential for life

- **Most plants and animals are mostly made of water**
- **Our body is about 70 % water**



Table: Types of		
	Elements	Types of Molecule
Water (Both Plants and Animals)		

- A water molecule is made up of 2 hydrogen atoms and 1 oxygen atom.
- There is only one type of water molecule...good old H<sub>2</sub>O
- Small molecule

# Source and Importance of H<sub>2</sub>O

H<sub>2</sub>O's key chemical role is to dissolve other chemicals of life and transport these chemicals from place to place. Plants and animals are made up of millions to billions of cells. Most of the chemical reactions that occur happen inside of the cells watery solution called cytoplasm. Example: Blood



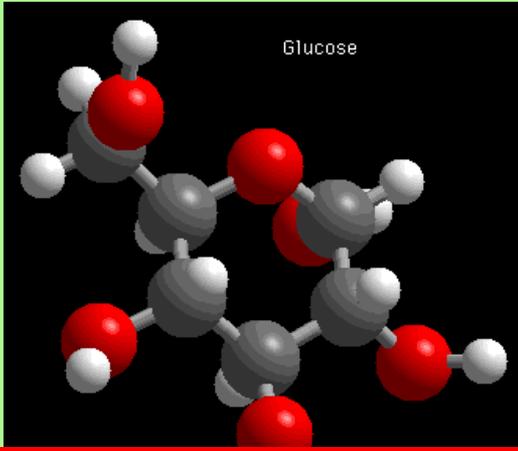
Sources of H<sub>2</sub>O  
rain, lakes, natural springs, or rivers

## Molecules Important for Life

Jobs/Importance (uses)	Sources

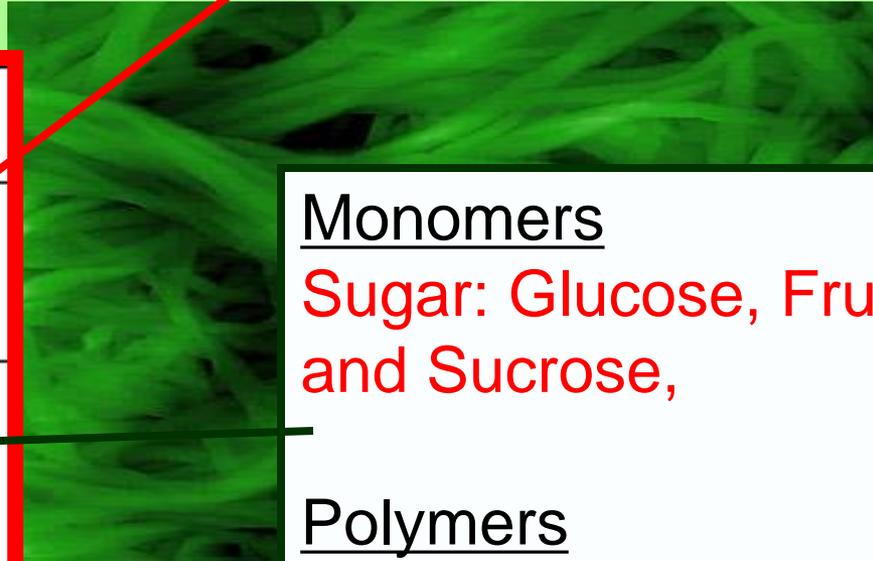


# Molecule = Carbohydrates



- Carbohydrates are made up of only three elements... Carbon, Hydrogen, and Oxygen

	Elements	Types of Molecule
Water (Both Plants and Animals)		
Carbohydrates		



## Monomers

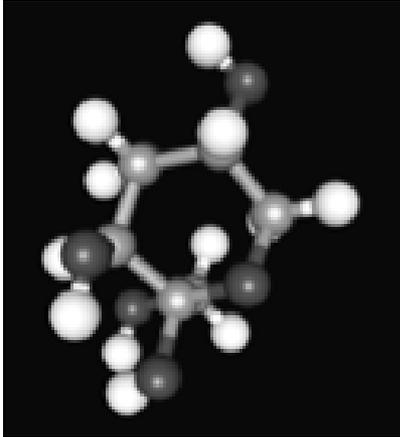
Sugar: Glucose, Fructose, and Sucrose,

## Polymers

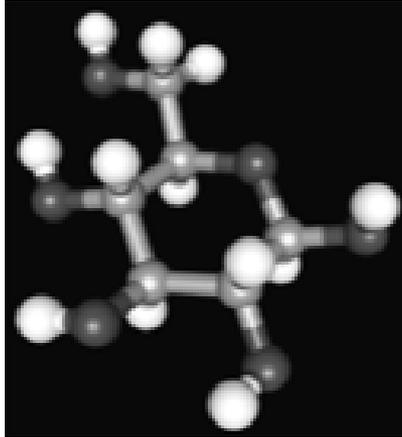
Starches

Cellulose (Plants only)

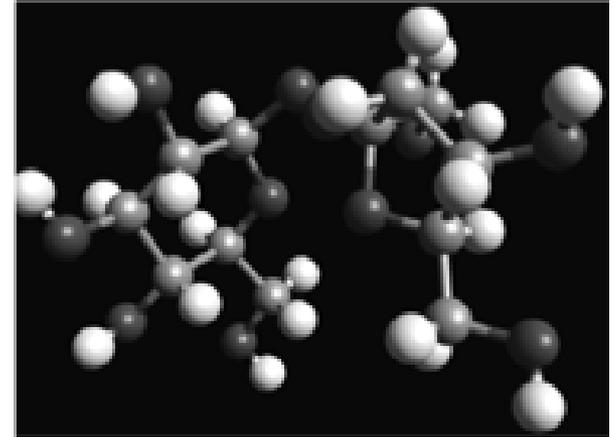
## Three Simple Sugars



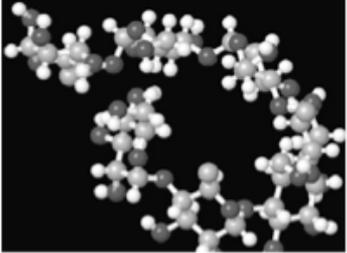
fructose



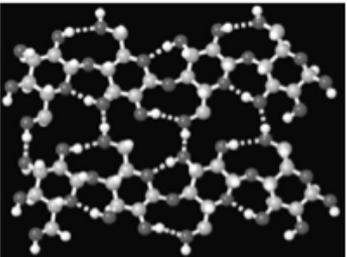
glucose



sucrose



Starch (above) and cellulose (below) are both made of glucose monomers.



starch

cellulose

Glucose is a monomer made by photosynthesis. Glucose makes up the polymers cellulose and starch

# Glucose is a “quick” source of ENERGY

## Jobs/Importance (uses)

Plants:

Animals:

- Glucose is the energy source for plant life and growth
- When plants make more glucose than needed, they store it in starch polymers. which **stores** thousands of **glucose** molecules. When plants need food (glucose), they break down starch molecules as needed.
- glucose also creates cellulose polymers, used for **plant structures** like leaves, stems, and cell walls.

Source of energy for animals, insulation for body temperature, and the surround of most cell parts.

The chemical formula for glucose is :

**Carbon - hydrogen - oxygen**

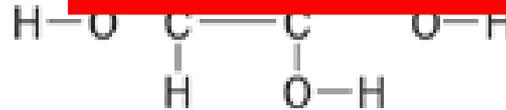
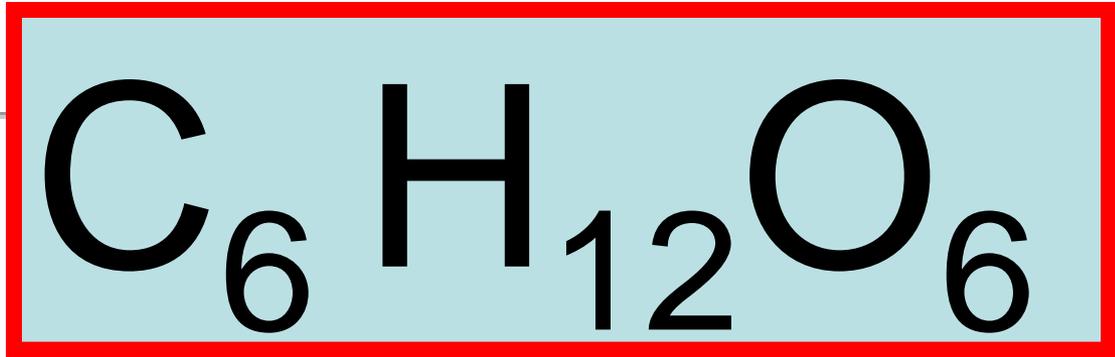


$C_6$

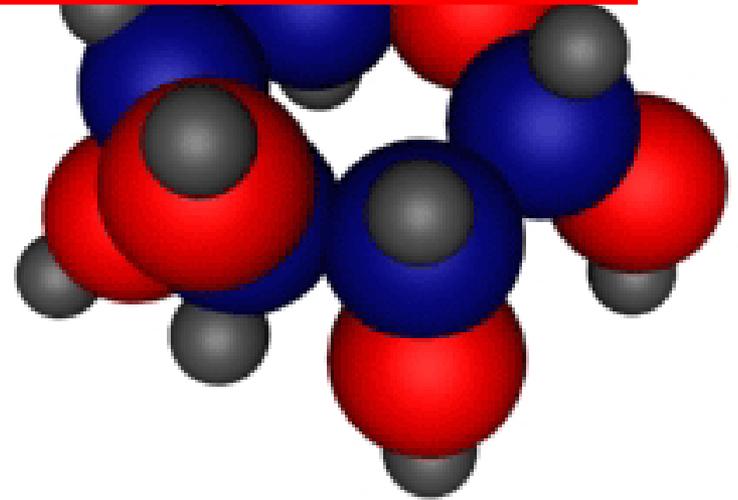
$H_{12}$

$O_6$

### Molecular Construction of Glucose



-  Hydrogen
-  Carbon
-  Oxygen



# Sources of Carbohydrates..Where does the energy come from?

Plants: Energy from sun reacts with  $\text{CO}_2$  and  $\text{H}_2\text{O}$  to produce glucose (photosynthesis)

Animals: Eating plants (potatoes, carrots, corn, beans, rice). Glucose reacts with oxygen to produce water and carbon dioxide (cellular respiration)

Sources
Plants:
Animals:

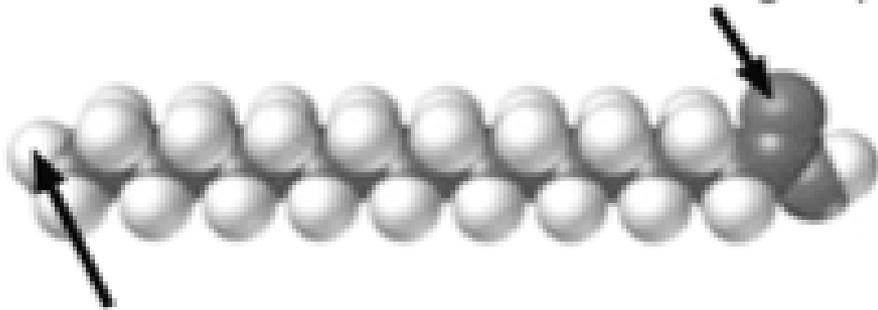
(Carbohydrates)

# Molecule = Lipids/Fats

## Stored energy with a bad name

stearic fatty acid

COOH group



H atom

- Made up of **monomer molecules called fatty acids**.
- Similar to carbs but have a hydrogen atom at one end.
- Other end is one carbon, 2 oxygen, and one hydrogen atom

# Fats- elements and types of molecules

- Fats consist of carbon, hydrogen, and oxygen atoms
- Saturated Fat - bonds are full and can not bond with hydrogen (not water soluble)
  - \*\*very difficult to lose off the body
  - \*\* too much can lead to severe health problems = (
- Unsaturated Fat - bonds are **not** full, can bond with hydrogen (water soluble)

	Elements	Types of Molecule
Water (Both Plants and Animals)		
Carbohydrates		
Fats		

# Importance of Fats



Fats			Plants:
			Animals:



- Plants have fats only as oils. They use oils as a food source for seeds while germinating.
- Animals use fats to store energy, insulate the body, and for the surrounding of most cell parts.

# Where does all of this fat come from?



**Plants make their own fats**, they can regulate it.

**But for humans...  
we are what we eat!**

**We get our fats from  
fatty foods like  
hamburgers, fried foods,  
avocados, snacks, etc...**

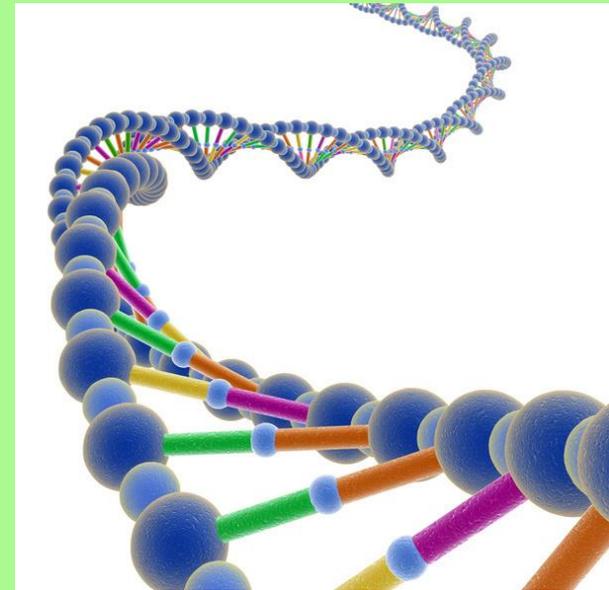
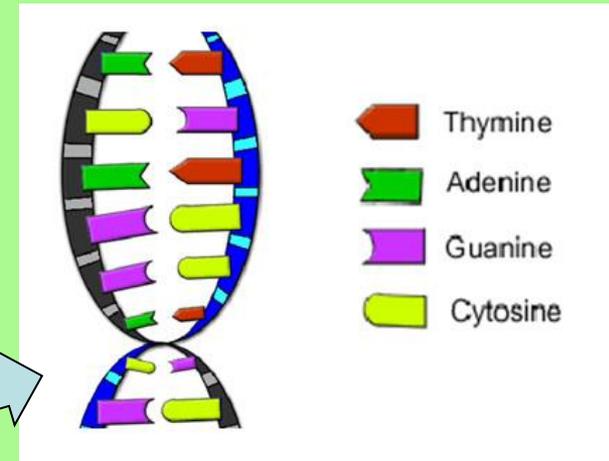
# Proteins

- Proteins are made of monomers called amino acids.
- Amino acids are made of Carbon, Oxygen, Hydrogen, Nitrogen, and sometimes Sulfur.
- Many important parts of each cell are made of proteins.
- Humans require 20 different amino acids. The human body can naturally make 12 of them, and must get the other 8 amino acids from food.
- Human body uses up to 100,000 different proteins to make YOU and all of your parts

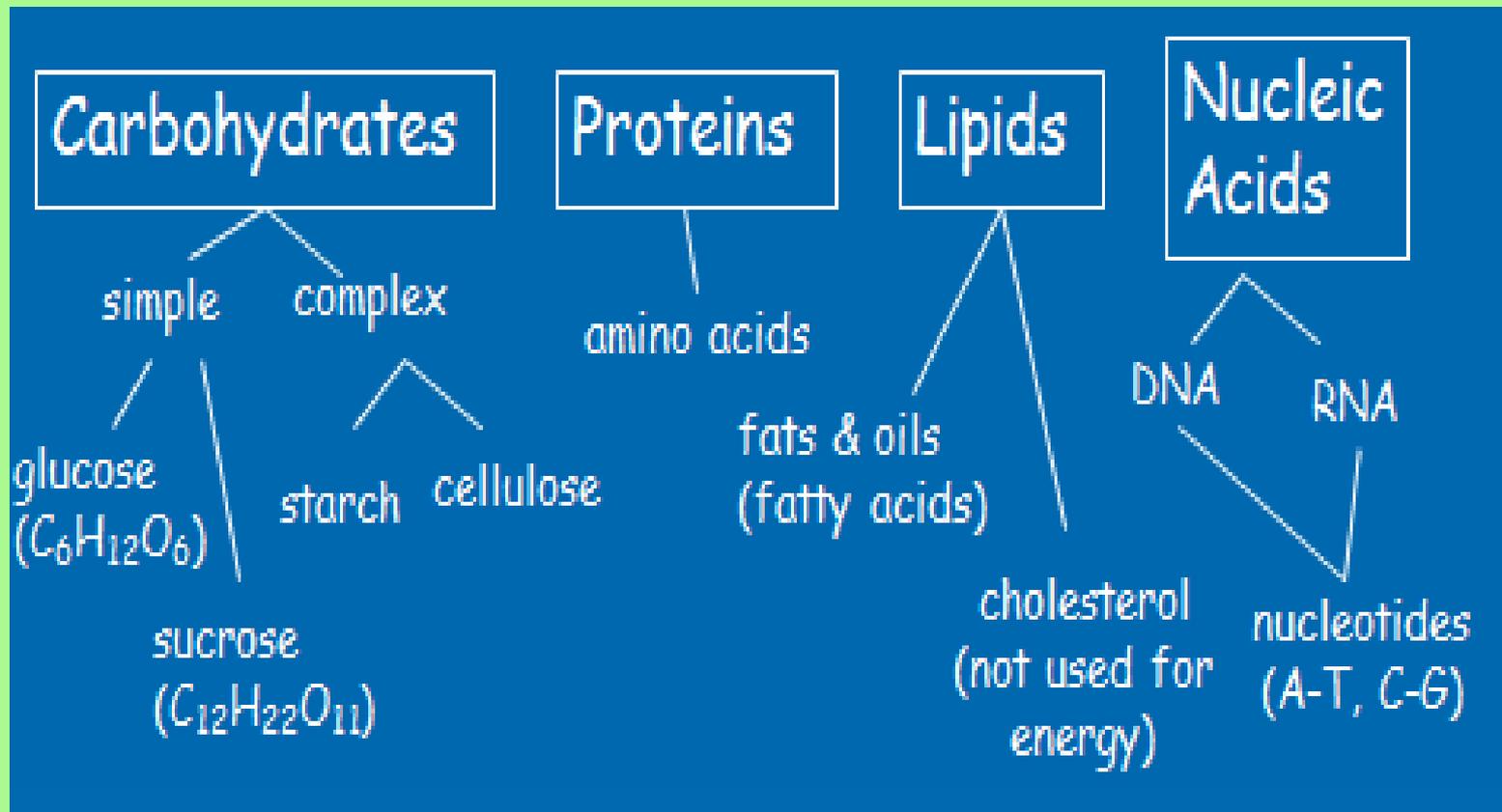


# DNA

- DNA is a polymer which holds an organism's genetic information.
- Made up of 4 different Nucleotides (monomers)
- Nucleotides are made of Carbon, Hydrogen, Oxygen, Nitrogen, and Phosphorus.
- DNA contains the genetic code required to create an organism, the "blue print" for the body.
- DNA is found in the nucleus of every human/ living organism's cells



Living things contain four major types of carbon-based molecules.



# Take Aways

- Overall, C,H,N,O,P, and S make up almost all the mass of the large (and some small) molecules in living things.
  - Calcium is important in humans too!
- 4 major organic molecules necessary for life are Carbohydrates (sugars and starches), Fats (lipids), Proteins, and DNA (Nucleic Acids)
- Smaller molecules such as water and salt, along with other vitamins and minerals help keep the body functioning properly and efficiently.