

"THE BIG 4" MACROMOLECULES

**There are four classes of
biological macromolecules:
Proteins, lipids, carbohydrates
and nucleic acids**

Before you can understand the topics in this unit there are some key vocabulary terms you need to know.

Macromolecule

Polymer

Monomer

What is a

MACROMOLECULE

What do these words mean?

Micro



MACRO

So What Is A Macromolecule?

A very large molecule, such as a polymer or protein, consisting of many smaller structural units linked together. Also called *supermolecule*.

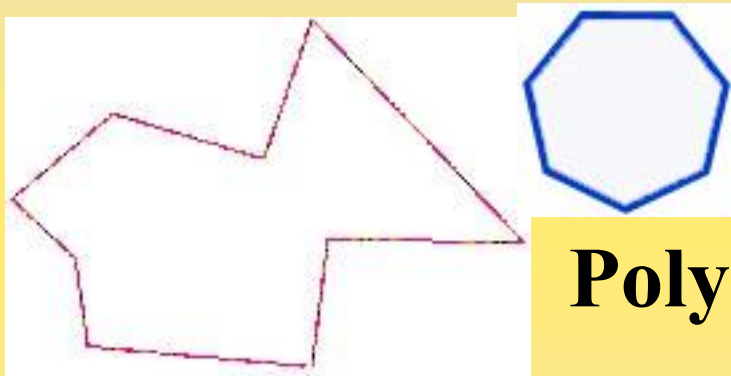
Biological Macromolecule

**All biological macro-molecule are
made up of a small number of
elements: Carbon, Hydrogen, Oxygen,
Nitrogen, Phosphorus and Sulfur**

Next Word.....

polymer

"Poly"



Polygons

Polygamy



Polyester



Means...

POLY means

MANNY

What does
“**Mono**”
mean?



A Polymer

Here are some analogies to better understand what polymers and monomers are....

EXAMPLE of POLYMER	MONOMER
A TRAIN	?
A NECKLACE	?

If the train is the whole polymer, what would be the small groups that make up the train? If the necklace is the polymer, what are the monomers that make up the necklace?

A Polymer

Here are some analogies to better understand what polymers and monomers are....

EXAMPLE of POLYMER	MONOMER
A TRAIN	THE CARS
A NECKLACE	EACH PEARL

If the train is the whole polymer, what would be the small groups that make up the train? If the necklace is the polymer, what are the monomers that make up the necklace?

Now you and a buddy



need to think of at least 2 other analogies for a polymer and its monomers.

Now we are ready to
begin our study of...

The Big Four



Three out of the 4 types of
biochemical macromolecules
can be found on food
nutrition labels...

Nutrition Facts

Serving Size 1 cup (240 mL)

Servings Per Container About 16

Amount Per Serving

Calories 90 **Calories from Fat** 0

% Daily Value*

Total Fat 0g **0%**

Saturated Fat 0g **0%**

Cholesterol Less than 5mg **1%**

Sodium 135mg **6%**

Total Carbohydrate 13g **4%**

Dietary Fiber 0g **0%**

Sugars 13g

Protein 9g

Vitamin A 10% • Vitamin C 4%

Calcium 30% • Iron 0% • Vitamin D 25%

Look at the label to the left. 3 of the 4 macromolecules can be found in foods.

The 3 biochemical molecules found on a nutrition label are:

1 **FAT** (0 grams in this product)

2 **Carbohydrates** (13 grams in this product)

3 **Protein** (9 grams in this product)



**What is the fourth
type of biochemical
macromolecule?**

The 4th type of biochemical macromolecules are the **NUCLEIC ACIDS**

The types of Nucleic Acids

–DNA (Deoxyribo**Nucleic Acid**)

–RNA (Ribo**Nucleic Acid**)

DNA

“DNA” is short for
DeoxyriboNucleic Acid

- Now you know why they just call it DNA!



When studying these biochemical molecules, we are interested in finding out.....

- what they do for living things.
- what they generally look like.
- what their monomers are.
- and how they may help the body gain energy to sustain life.



Keep the following in mind when studying this material:

Nucleic Acids

Carbohydrates

Lipids

Proteins

What they look like

What they do/Where are they

**What are they made up of-
at the level of atoms**

CARBOHYDRATES

WHAT DO THEY DO?

- ✓ They are the main source for the body to gain energy. They are our fuel!
- ✓ They make up the cell wall in plants which allow them to grow tall, without this carbohydrate, a plant would be a mushy mess! This type of carbohydrate is called Cellulose.

THINK: CARBS= ENERGY and CELL WALLS

CARBOHYDRATES

WHERE ARE THEY FOUND?

- Most carbs come from plants.
- cell walls of plants ---
- fruits, vegetables, peas, beans,
- SUGAR comes from a plant and so does FLOUR! (pasta, potatoes, bread, candy, cookies)
- In some animal products- MILK

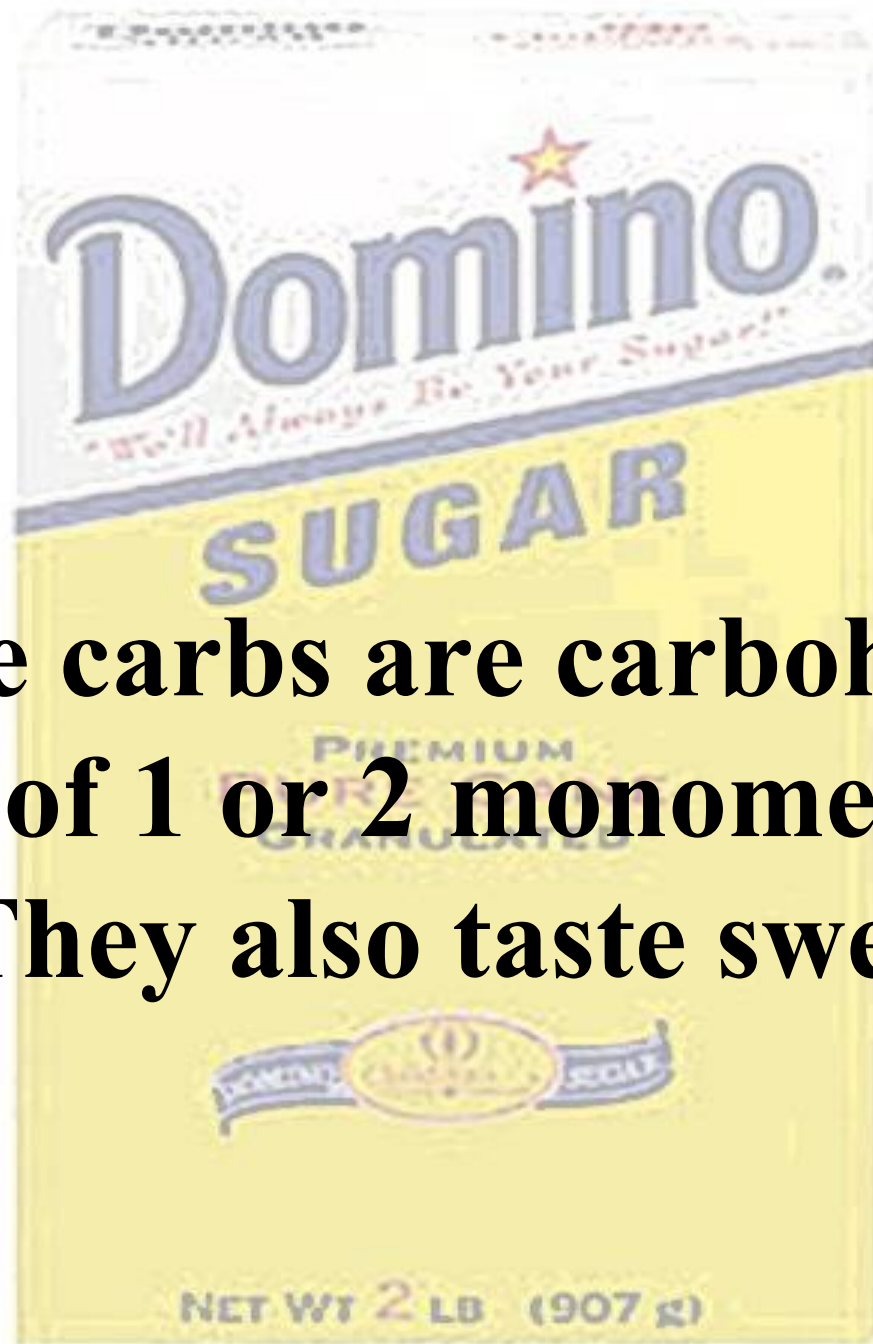
CARBOHYDRATES

TYPES

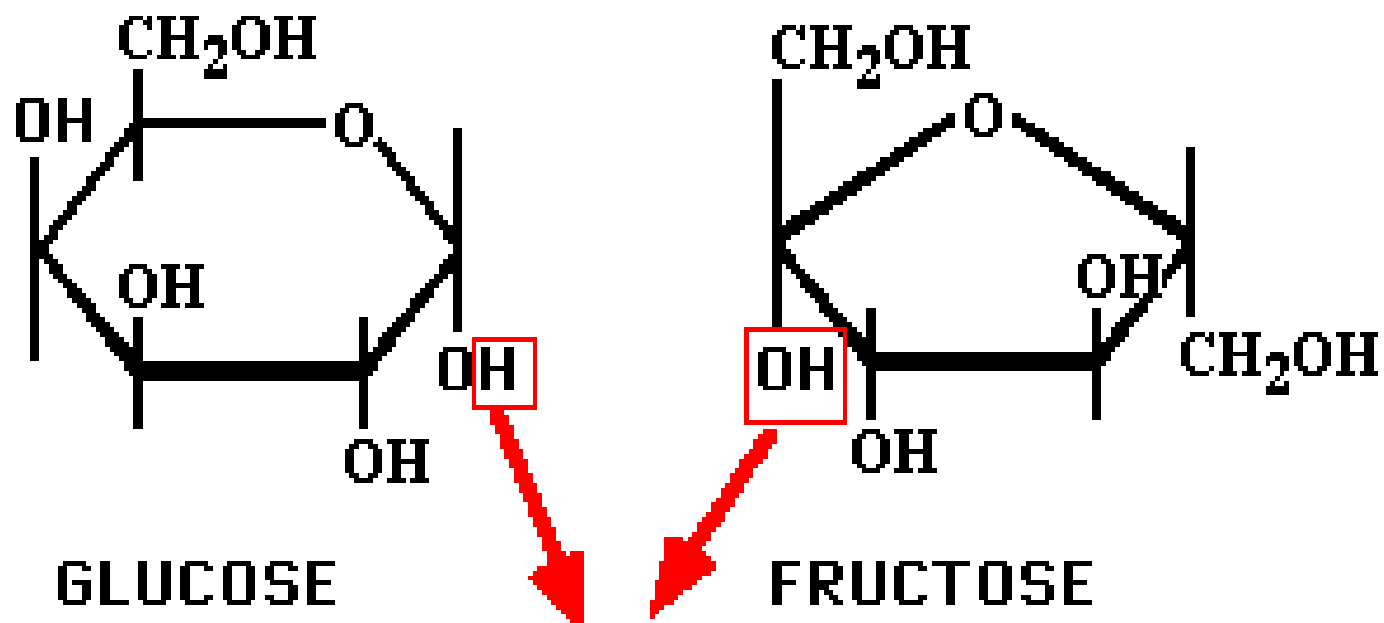
**THERE ARE 2 TYPES OF
CARBOHYDRATES**

Simple

Complex



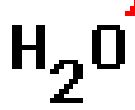
**Simple carbs are carbohydrates made up of 1 or 2 monomers. (sugar)
They also taste sweet.**



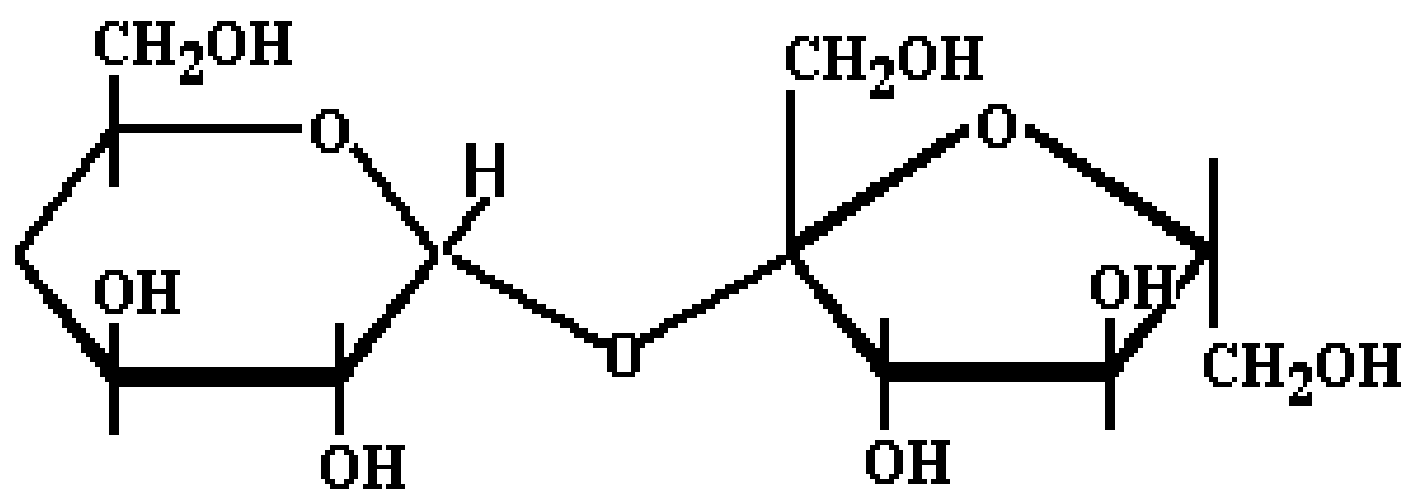
Dehydration
Synthesis
of Sucrose.

GLUCOSE

FRUCTOSE



SUCROSE



A basket of fresh fruits including strawberries, grapes, kiwi, blueberries, an orange, and apples.

COOKIES and CANDY

CAKES

FRUITS

Simple Sugars



Complex Carbohydrates... What are they?

**Complex Carbohydrates are polymers
made up of many monomers.
Most also taste starchy.**

Complex Carbohydrates

FIBER

WHOLE GRAINS

STARCHES

PASTAS



BREADS

VEGETABLES



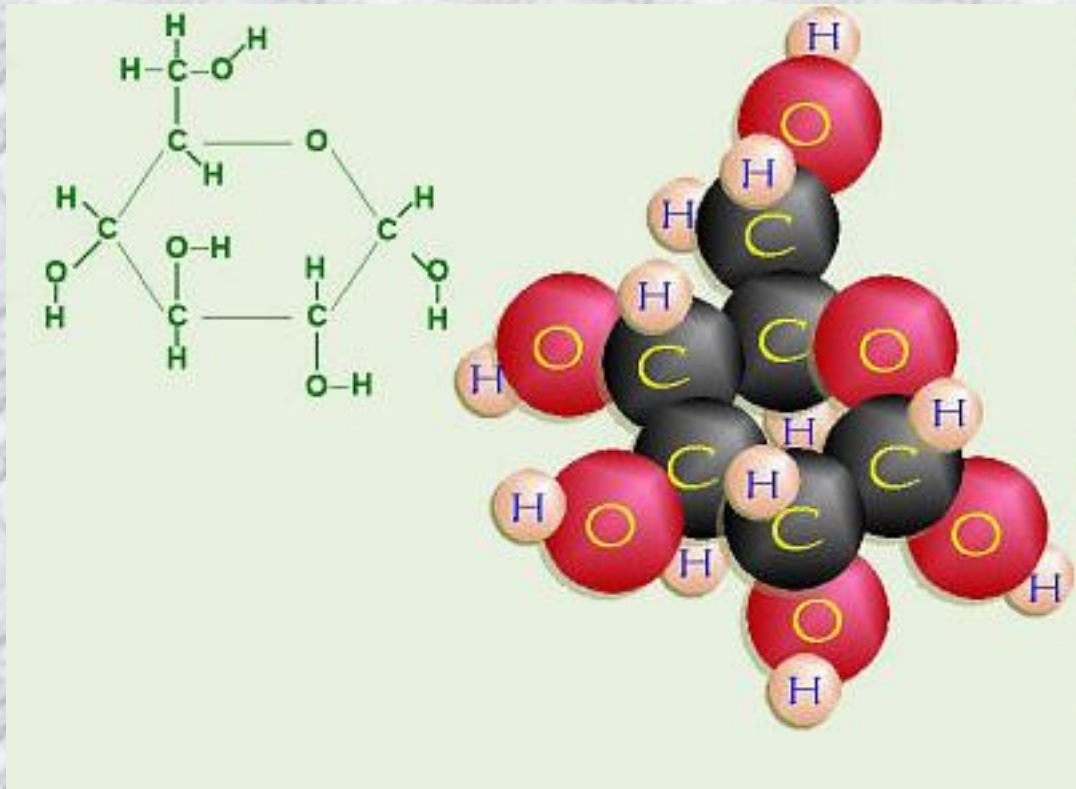
CARBOHYDRATES

MADE UP OF...

Carbohydrates are chains (polymers) made of monomers. The most common monomer of carbohydrates is...

GLUCOSE

The shape of Glucose is
a hexagonal ring



CARBOHYDRATES

AT THE ATOM LEVEL

Each carbohydrate is made up of...

Carbon, Hydrogen, and Oxygen

THINK: “CHO”

PROTEINS

WHAT DO THEY DO?

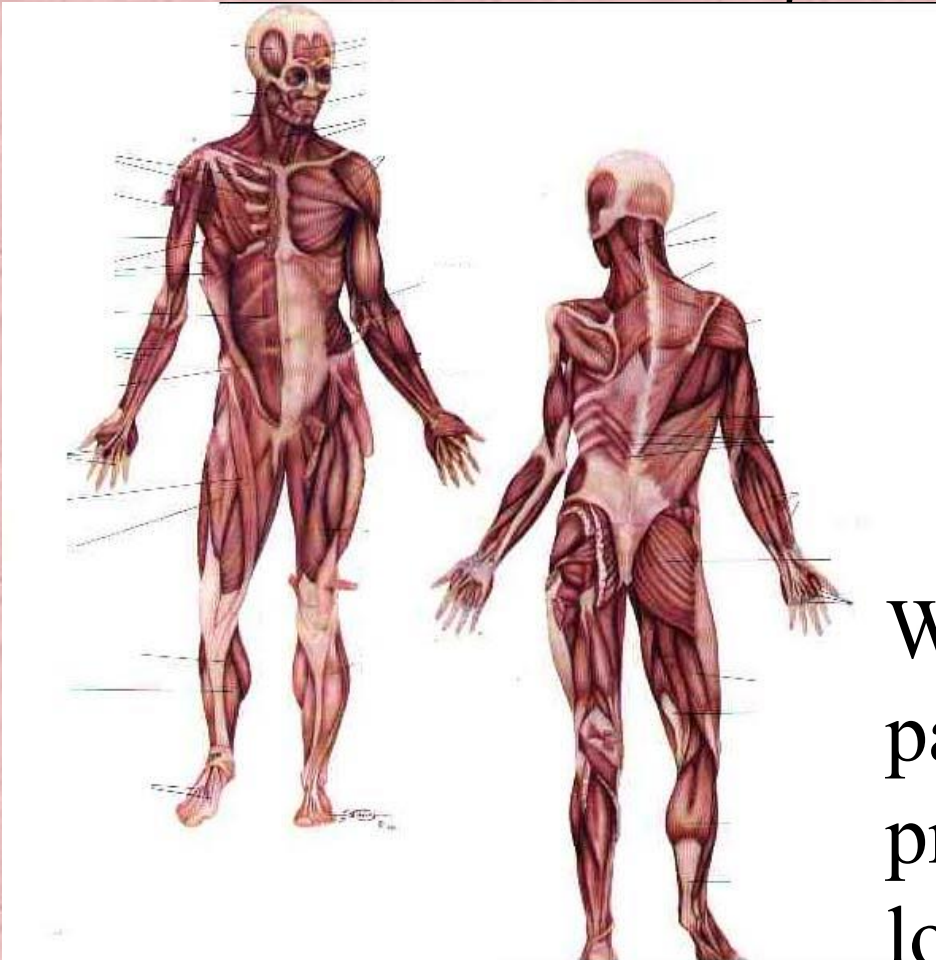
- ✓ They are the major structural molecules in living things for growth and repair : muscles, ligaments, tendons, bones, hair, skin, nails...**IN FACT ALL CELL MEMBRANES have protein in them**
- ✓ They make up antibodies in the immune system
- ✓ They make up enzymes for helping chemical reactions
- ✓ They makeup non-steriod hormones which

THINK: Proteins= membranes, enzymes, antibodies, non-steriod hormones, structural molecules, “MEANS”

MORE ON PROTEINS...

The following slides give you a little more in depth info on things that are made of proteins...

Muscles, ligaments, tendons, and bones



Without these
particular structural
proteins, we would
look more like this....



Well, maybe not exactly...

Hair, Skin, and Nails



Microscope View of Skin and Nails



This is skin



This is a nail

Cell Membrane



The cell membrane surrounds everything in a cell so it doesn't leak out. It is kind of like the balloon in a water balloon.

The cell membrane is made mostly of protein AND lipids.

Antibodies



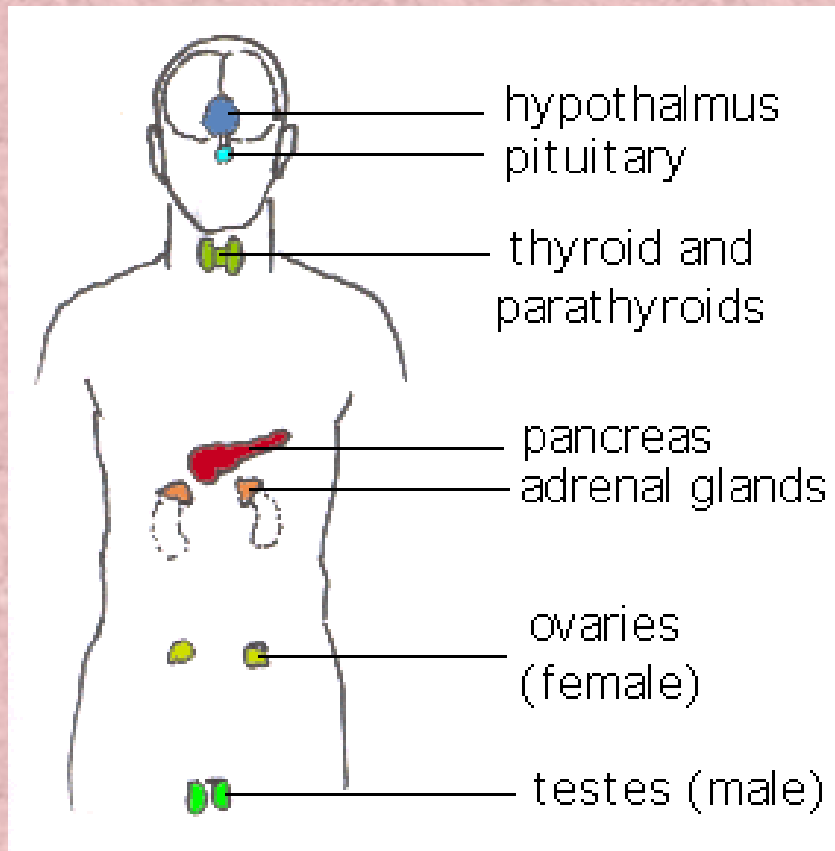
Antibodies are part of the immune system. When something enters the body that isn't supposed to be there, like certain bacteria, antibodies find the invader and stick themselves onto it. When a white blood cell finds the invader covered with antibodies, it knows it doesn't belong there and kills it.

Enzymes

Enzymes are proteins that speed up chemical reactions. If you didn't have enzymes in your stomach to speed up digestion, the food would rot in your stomach because it would take so long!

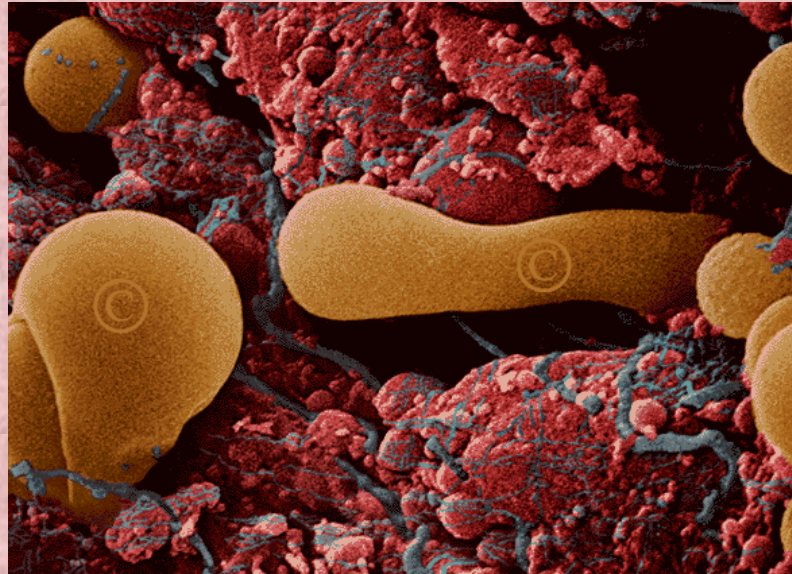
HORMONES

Hormones are chemicals made in glands that are in one place in the body and then put into the blood to be used in another.



These are where the hormone producing glands are located in your body.

The thyroid is found in the middle of your neck, by your voice box.
Here is a picture of those cells secreting the thyroid hormone.



(The yellow stuff is
thyroid hormone)

**Thyroid hormone regulates how fast your body uses energy.
If you have an over active thyroid, you use energy quickly and tend to be
very thin and have a hard time putting on weight.**

**If you have an under active thyroid gland, you use energy very slowly
and tend to carry more body fat and have a difficult time losing it.**

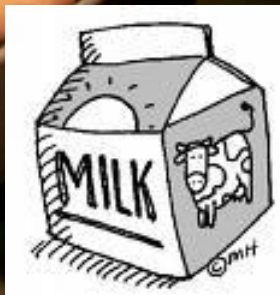
**Don't be quick to think you have a thyroid problem if you are
overweight, chances are it's actually your eating and exercise habits!**

PROTEINS

WHERE ARE THEY FOUND?

- **In plant foods- in the cell membranes**
- **In animal products- in the cell membranes- in the muscles or living things- cows, chicken, fish...**

Proteins



Proteins

Aside from the protein found in animal sources...protein can also be found in fruits, vegetables, grains, and nuts.

acids)

(it just does not have as many amino



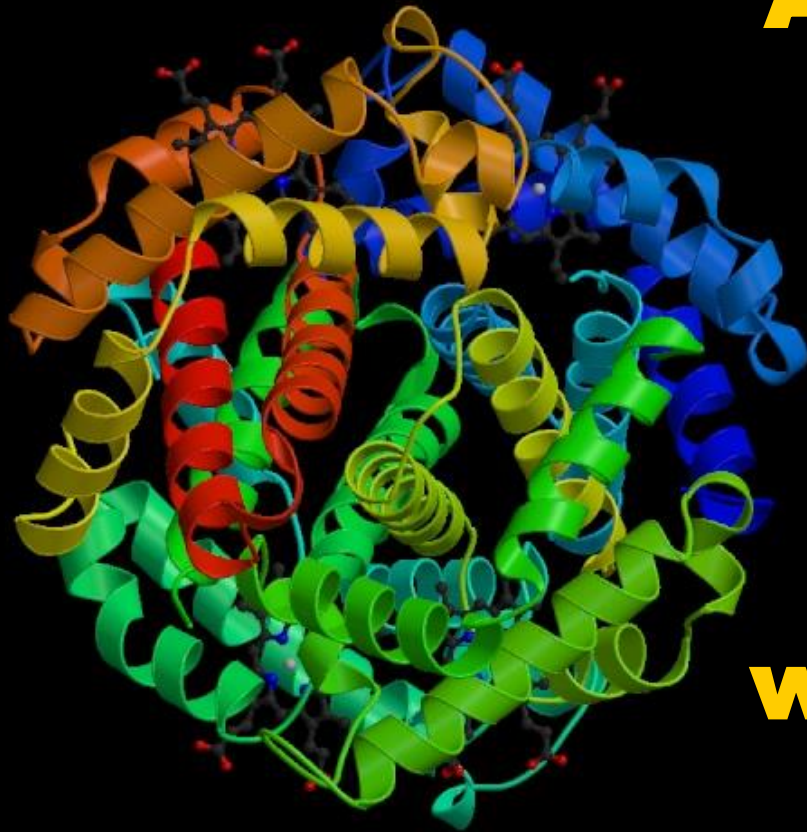
PROTEINS

MADE UP OF...

Proteins are made of long chains (polymers) made of monomers. All proteins are made of the monomer...

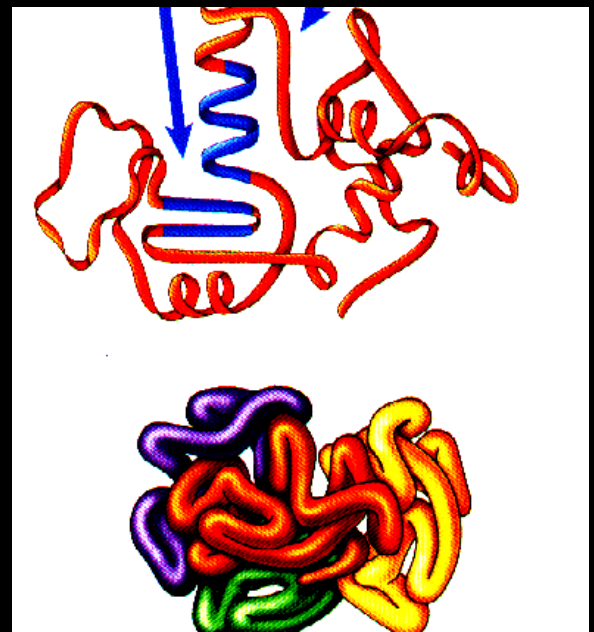
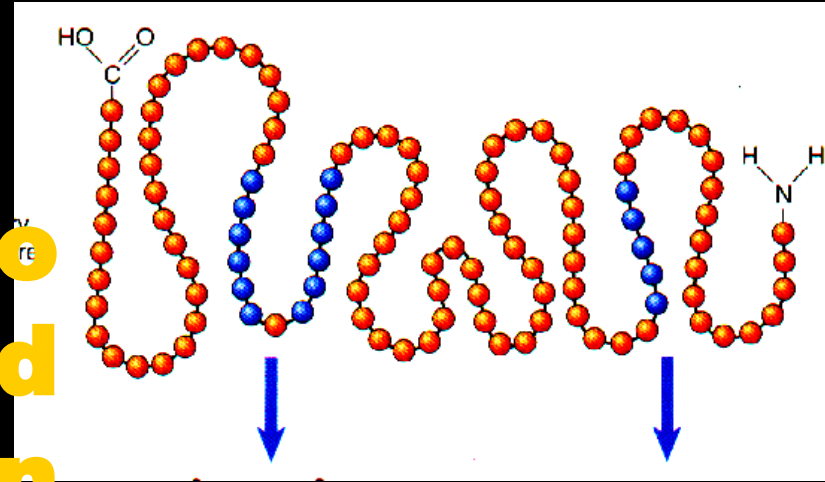
AMINO ACID

The shapes of proteins are
like a balled up piece of
string



**Amino
Acid
chain**

**All
wound
up**



PROTEINS

AT THE ATOM LEVEL

Each protein is made up of...

**Carbon, Hydrogen, and Oxygen,
Nitrogen and sometimes Sulfur**

THINK: “CHONS”

Lipids

WHAT DO THEY DO?

- ✓ They are a great source of STORED ENERGY so we have it in the future.
- ✓ They INSULATE the body to maintain normal body temperature and they CUSHION the internal organs for protection.
- ✓ They produce hormones for the body called STERIODS
- ✓ They waterproof surfaces of animals, plants, and fruits- these are waxes!

THINK: Waterproof, insulate, steriods, energy, cushion... “WISE C”

LIPIPS...Some interesting info

Waterproofing...

- Fruits produce a waxy coating to keep from drying out.
- The cells in a tulip make a wax which helps coat the leaves.
- Ear wax traps dust, sand, and other foreign particles from going deeper into the ear and causing damage.
- Beeswax- a structural material to hold honey in the hive



LIPIPS...Some interesting info

Steroids...

There are many different types of steroids.
They are all lipids. Their functions vary.
Some common steroids are:

SEX STEROIDS



Like testosterone and estrogen

ANABOLIC STERIODS



They increase muscle

CHOLESTEROL

LIPIPS...Some interesting info

**NATURAL STERIODS IN OUR
BODY INCREASE MUSCLE
GROWTH AND BONE
DEVELOPMENT AND ARE GOOD.
THE ILLEGAL ONES THAT ARE
SYNTHETIC ARE BAD.**

very unhealthy



LIPIDS

WHERE ARE THEY FOUND?

- **In plants- in the seeds**

- **In animals- in adipose tissue, connective tissue, in animals**

- **Lipids make up the cell membrane of all cells.**

LIPIDS

OILS

BUTTER

MARGARINE



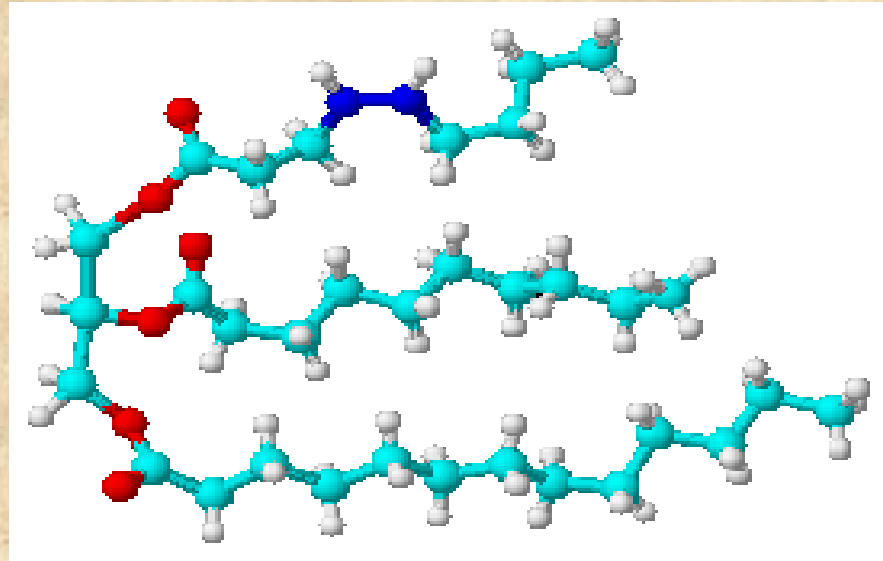
LIPIDS

MADE UP OF...

Lipids are chains (polymers) made of monomers. The most common monomer of lipids is...

TRIGLYCERIDES

The Shape of a triglyceride is like
the letter **E**



This is a triglyceride molecule

LIPIDS

AT THE ATOM LEVEL

Each carbohydrate is made up of...

Carbon, Hydrogen, and Oxygen

THINK: “CHO”

OH NO CHO!

Lipids like Carbs?

You might have noticed that both carbohydrates and lipids have the elements Carbon, Hydrogen, and Oxygen.

“CHO”

A carbohydrate, has twice as many hydrogen atoms as the number of oxygen atoms.



(This is a carb= there are double the number of H compared to O)

On the other hand, lipids have a lot more than twice the amount hydrogen atoms as the number of oxygen atoms.



ENERGY

Three of the BIG 4 provide us with energy through the food we eat:

BIG 4 MACROMOLECULES	Number of Calories it provides
Carbohydrates	
Proteins	
Lipids	
Nucleic Acids	

ENERGY

**Energy that is gained by
consuming food is called a**

CALORIE



Energy that we gain by the consumption of food is measured in **Calories**.

If you drink a glass of skim milk, you will get a gain of 90 Calories of energy for your body.

Energy Gained From Carbohydrates

Eating 1 gram of carbohydrate provides
your body with 4 Calories.



Energy Gained from Protein



Eating 1 gram of protein provides your body with 4 Calories.

Energy Gained from Lipids

Eating 1 gram of fat provides your body with
9 Calories.

Notice if you eat 1 gram of fat, you are gaining *more than twice* the amount of Calories than from a gram of carbohydrate or protein!

Nucleic acids

The nucleic acids in food are not considered a substance that the body uses to gain energy.

ENERGY

So...

BIG 4 MACROMOLECULES	Number of Calories it provides
Carbohydrates	4
Proteins	4
Lipids	9
Nucleic Acids	0

TEST: Are you smart? If you eat a sandwich with 46 grams of carbs and 24 grams of protein and 10 grams of fat, how much energy will you gain?

370

Simple tests can detect the presence of proteins, lipids and carbohydrates in given samples (i.e. various food items)



Testing for carbohydrates

- Lugol's reagent (iodine solution)
- Benedict's solution



Testing for the presence of starch (complex sugar)

Lugol's reagent
(iodine solution)
changes from
yellowish-brown
to dark
purple/black.



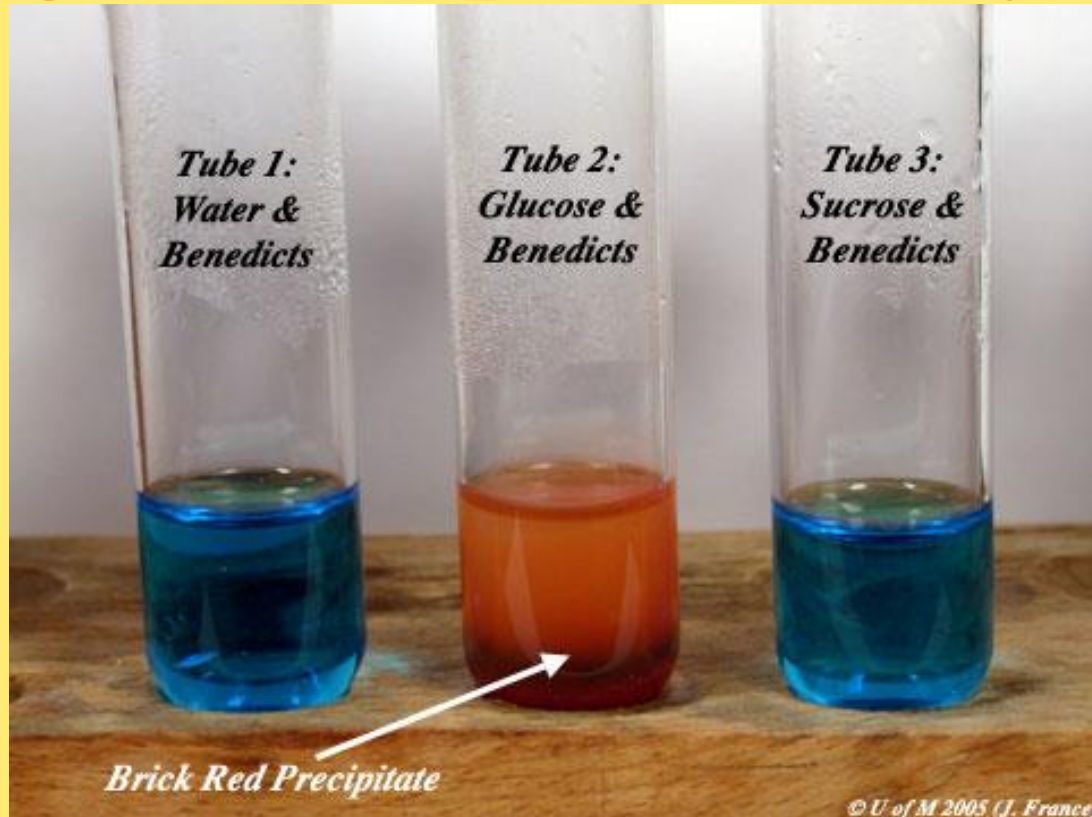
Testing for simple carbohydrates

Benedict's solution is used to test for simple carbohydrates.

Benedict's solution is a blue colored liquid that contains copper ions.



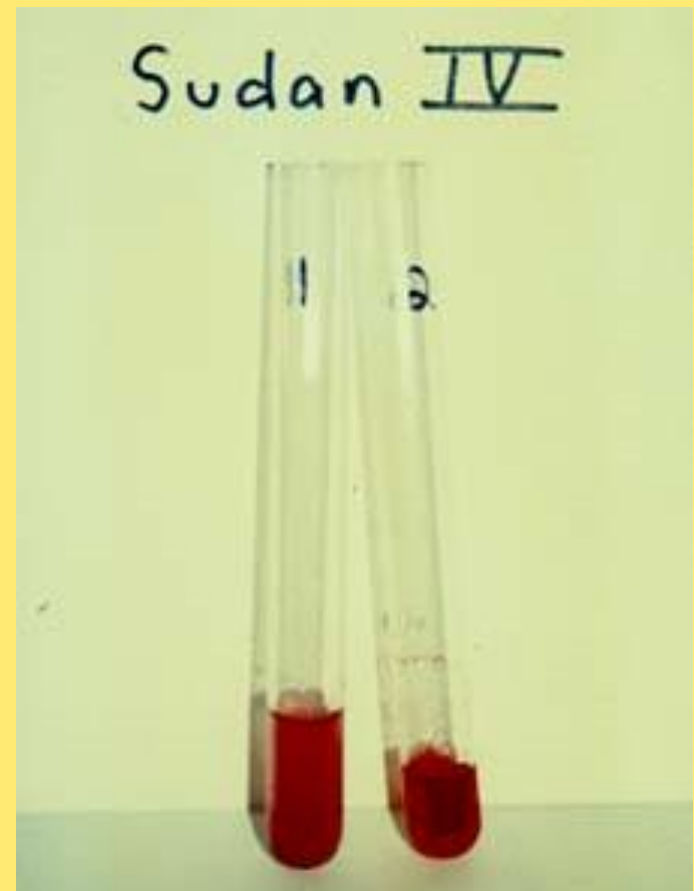
Testing for simple carbohydrates



When Benedict's solution and simple carbohydrates are heated, the solution changes to orange red/ brick red.

Testing for lipids

- Grease spot test/Brown paper test
- Sudan Red test



Brown paper test for lipids

As we all know from experience, lipids leave translucent spots (grease spots) on unglazed brown paper bags.



Sudan Red test for lipids

Sudan red is a fat-soluble dye that stains lipids red. Using Sudan red can show the amount and the location of lipids.



Testing for proteins – Biuret test

Biuret solution is a blue liquid that changes to purple when proteins are present and to pink in the presence of short chains of amino acids. The copper atom of the biuret solution reacts with the bonds between the amino acids to cause the color change.

Testing for proteins – Biuret test

