Lesson 1

Organic vs. Inorganic Molecules

BIOCHEMISTRY – Organic Compounds

- What do all cells need to survive?

  NUTRIENTS

- Why do our cells need nutrients?
- To maintain homeostasis

  Synthesis (building molecules)

  To repair themselves

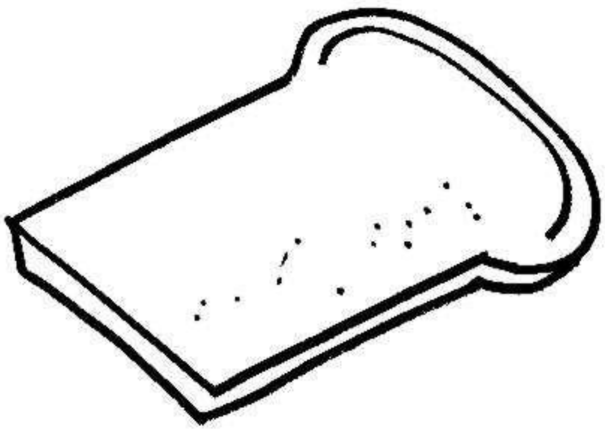
  For ENERGY

  Chemical reactions

  Fighting infections

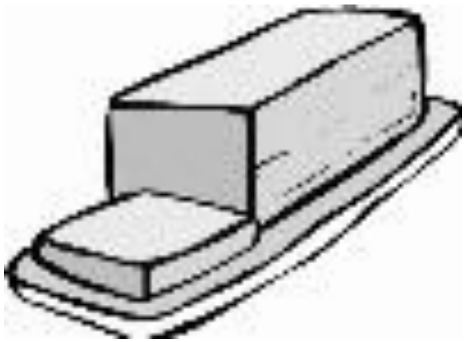
3 Types of Complex Nutrients

Carbohydrates (Starch)



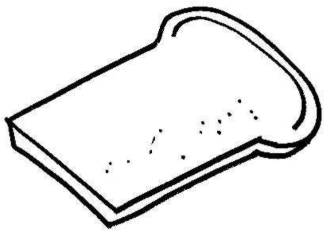
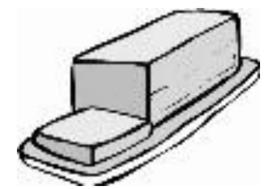
Protein

Lipids (fats)



How can these nutrients get into the cell if they are **<u>too large</u>** to pass through the cell membrane?

they must be **<u>digested</u>** into <u>smaller</u> building blocks

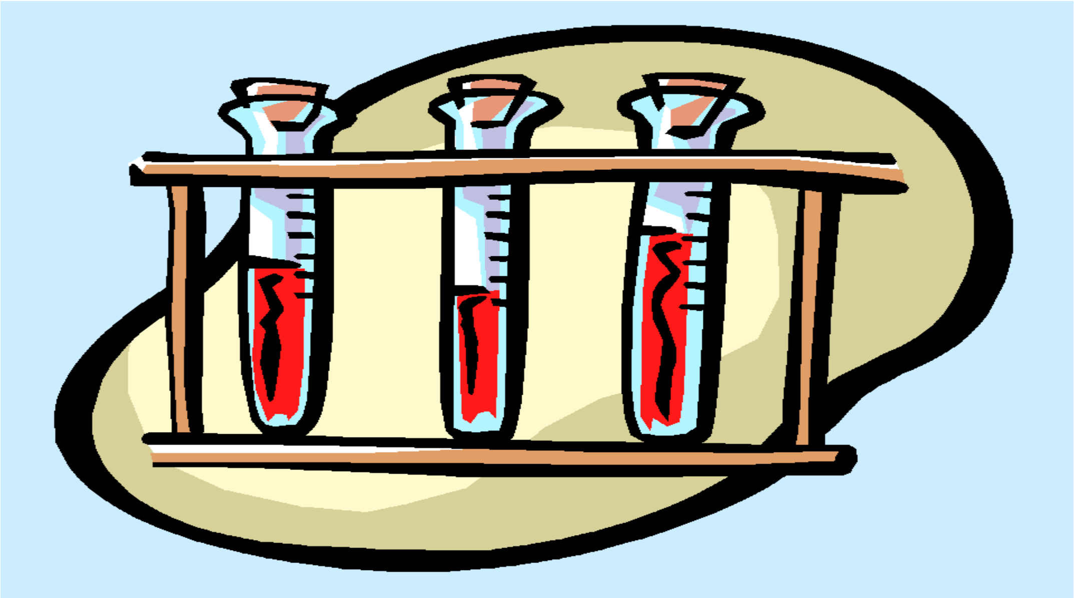
Carbohydrates (Starch)	Proteins	Lipids
		
↓	↓	↓
simple sugars (ex. Glucose)	amino acids	3 fatty acids & 1 glycerol

BrainPOP | Body Chemistry

But what is <u>even smaller</u> than these building blocks?

The components of their chemical make up!

- Name as many <u>elements</u> as you can!!!!

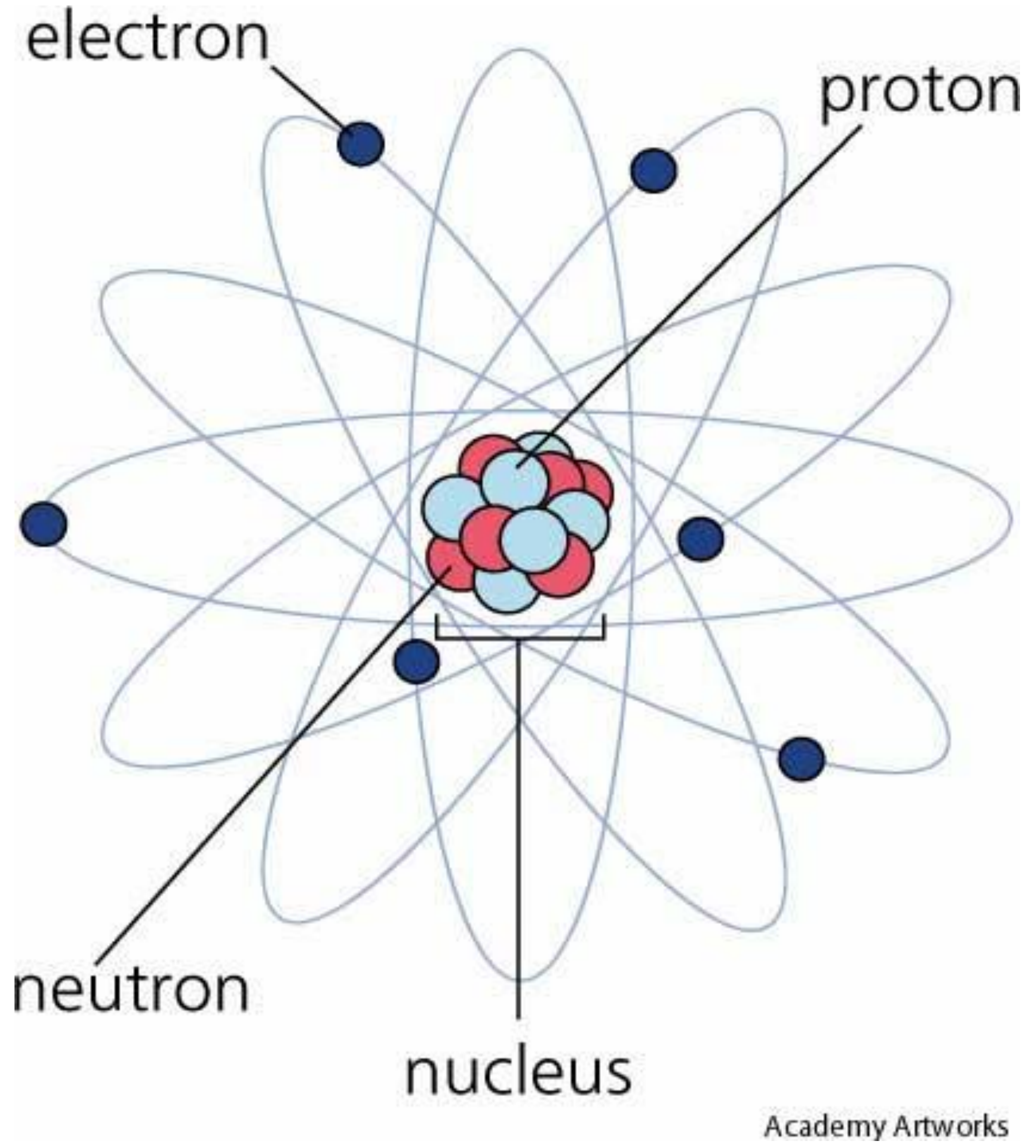


[Video - Meet The Elements Song]

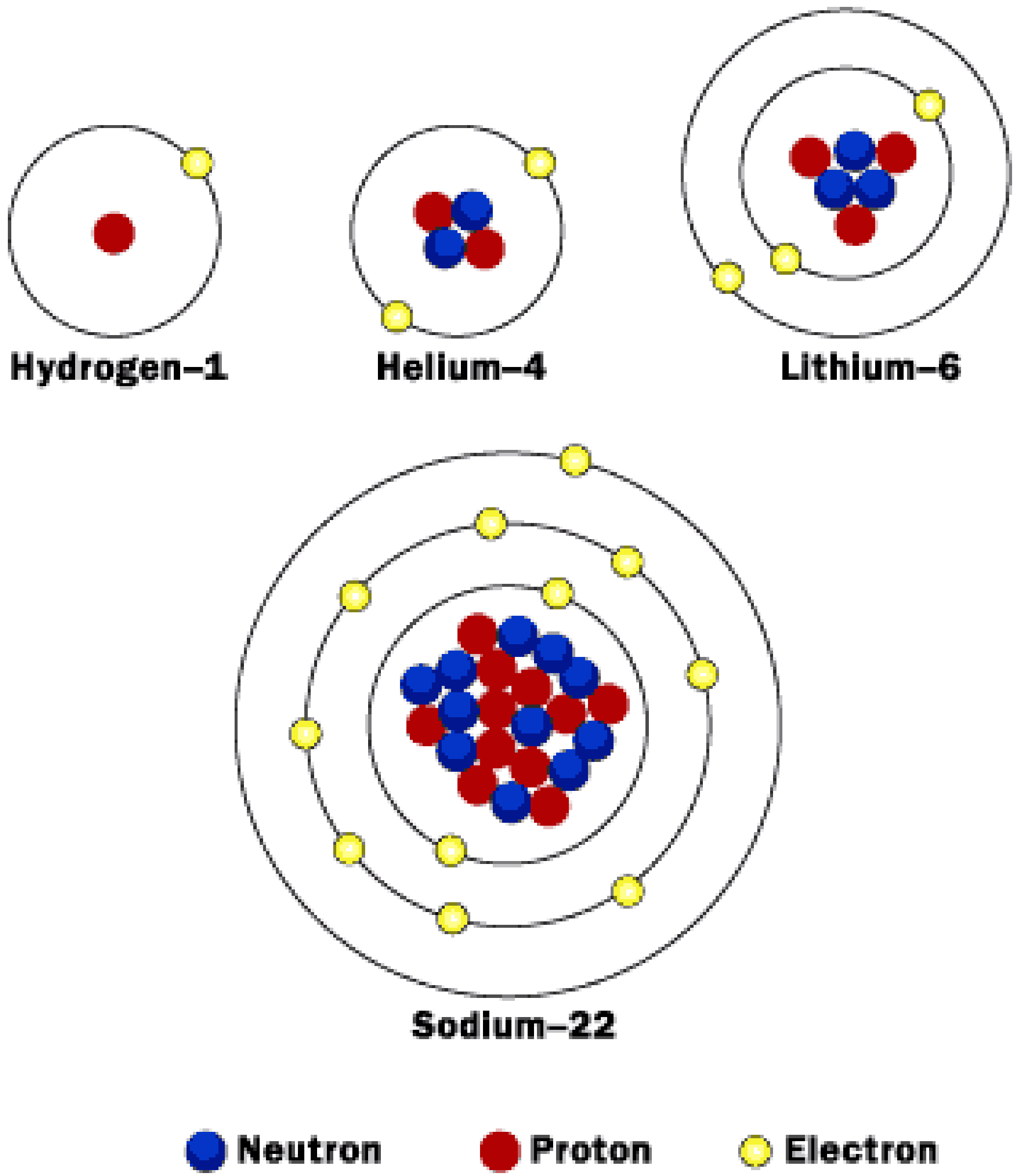
The Periodic Table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	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
5	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
6	55 Cs	56 Ba	*	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
7	87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uuq	115 Uup	116 –	117 –	118 –

* LANTHANIDE SERIES	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
** ACTINIDE SERIES	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

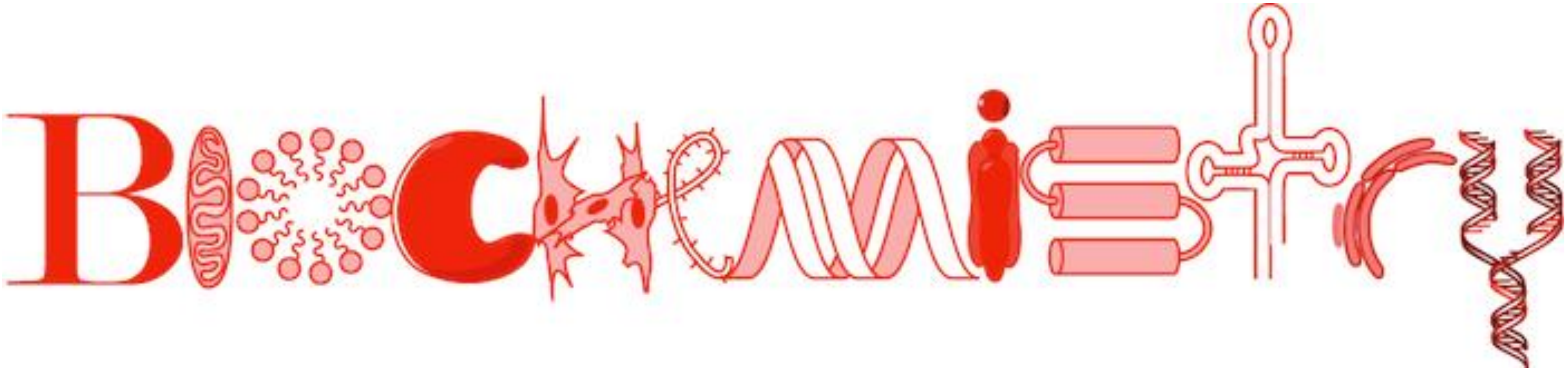

electron
proton
neutron
nucleus
Academy Artworks

Isotopes of Hydrogen, Helium, Lithium and Sodium



Biochemistry

- The study of the chemical processes and compounds in living things
- Water (H_20) is the most important molecule for CHEMICAL REACTIONS in living things

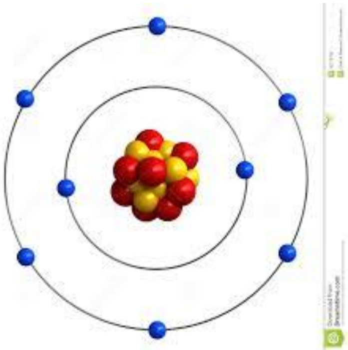


WHAT COULD A BIOCHEMIST DO?

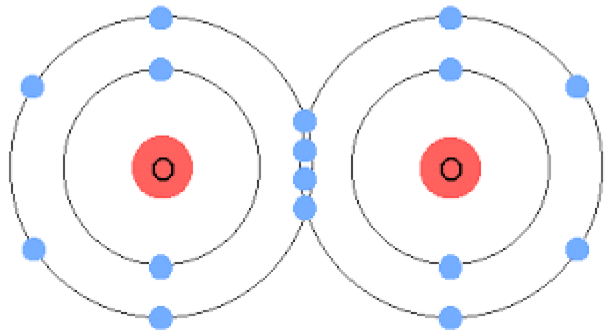
- Discover how proteins work by determining the 3-D structure
- Develop a vaccine to prevent a flu
- Develop new fuels like ethanol
- Use green fluorescent protein to investigate how cells work
- Research, research, research

Biochemistry Vocabulary

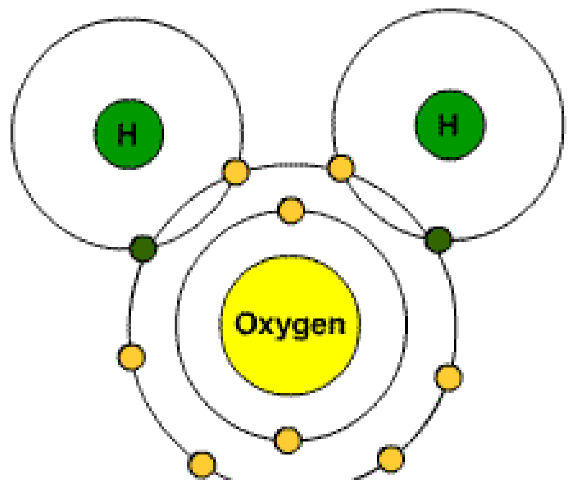
- *Atoms* – basic unit of a chemical element; Oxygen (O)

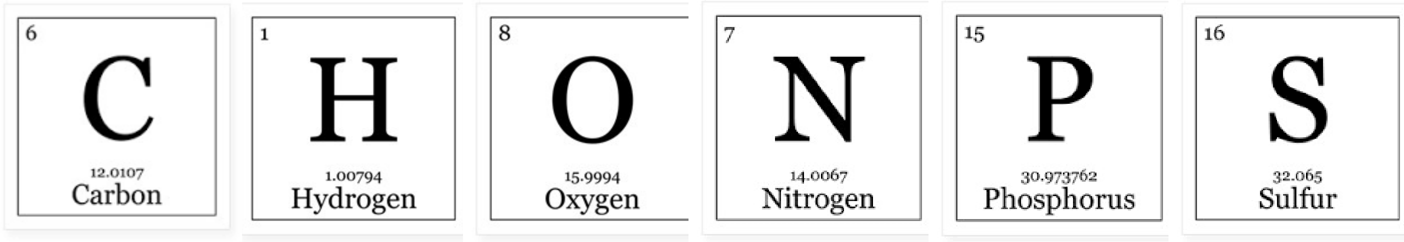


- *Molecules* – group of atoms bonded together; Oxygen gas (O_2)



- *Compounds* – form by combining 2 or more different elements; water (H_2O)



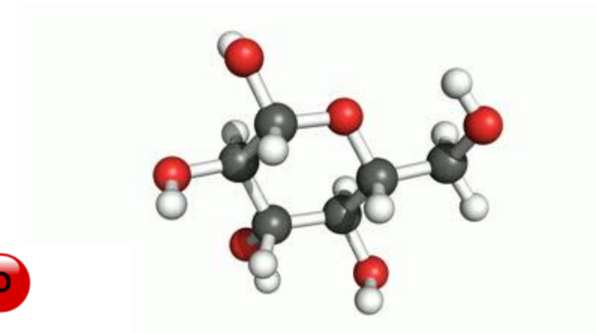


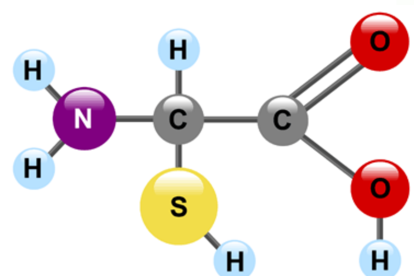
- the most common elements in living things
  - Carbon
  - Hydrogen
  - Oxygen
  - Nitrogen
  - Phosphorous
  - Sulfur
- many others are also required in lesser amounts
    - Ex. Iodine, Sodium, Iron, Calcium, Potassium, etc.

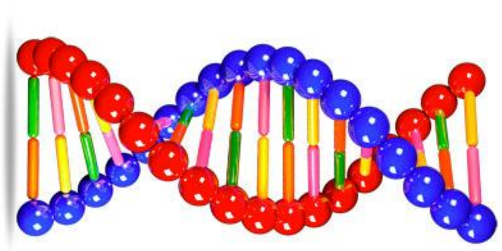
Compounds in Living Matter

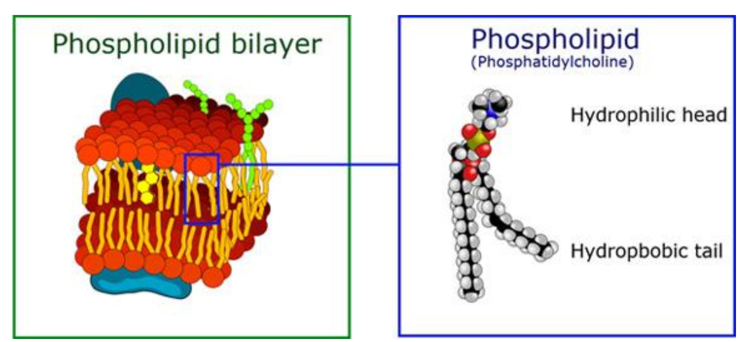
Organic Compounds

- Have a combination of Carbon (C) & Hydrogen (H)
- Contain high-energy bonds
- 4 major organic compounds:
  1) Carbohydrates
  2) Lipids
  3) Proteins
  4) Nucleic acids





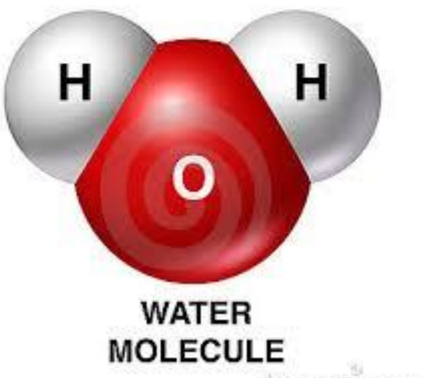


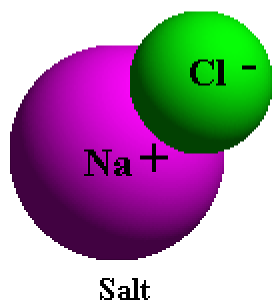


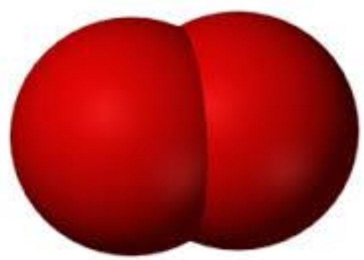
Compounds in Living Matter

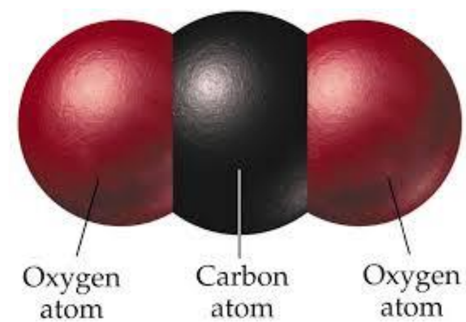
Inorganic Compounds

- LACK combination of C & H (may have 1 or none)
- Do NOT contain high energy bonds
- Ex. Water, salts, oxygen gas, carbon dioxide









Organic or Inorganic?

- Identify each compound and determine if it is organic or inorganic

H_2O	$C_6H_{12}O_6$	CO_2	H_2CO_3
Water	Glucose	Carbon Dioxide	Carbonic Acid
Inorganic	Organic	Inorganic	Organic
Lacks Carbon	Both C & H	Lacks Hydrogen	Both C & H

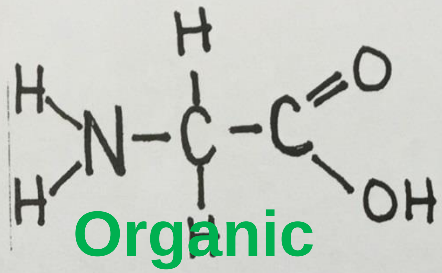
Identify each as Organic or Inorganic

$C_6H_{12}O_6$

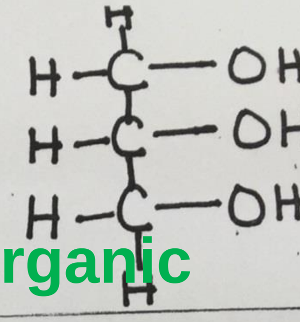
Organic

H_2SO_4

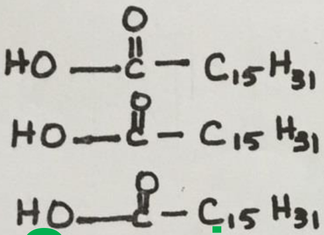
Inorganic



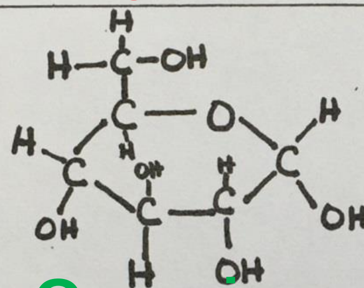
Organic



Organic



Organic



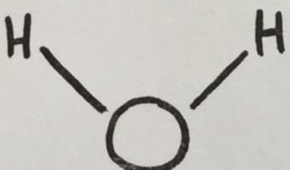
Organic

$O=O$

Inorganic

NH_3

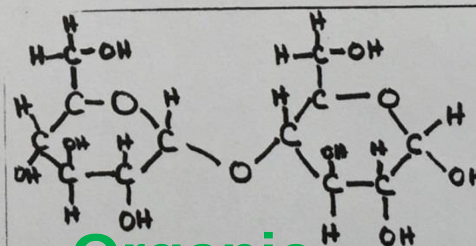
Inorganic



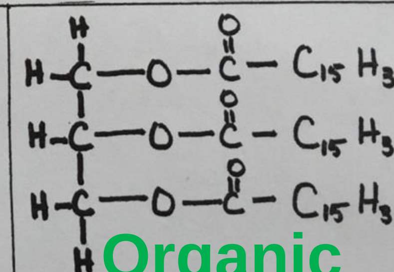
Inorganic

$O=C=O$

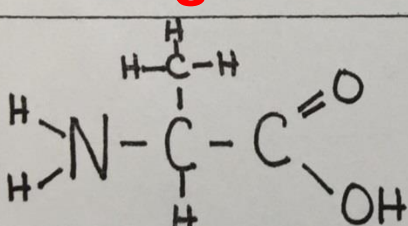
Inorganic



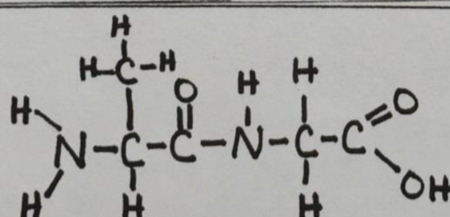
Organic



Organic



Organic



Organic

H_2O

Inorganic

NaCl

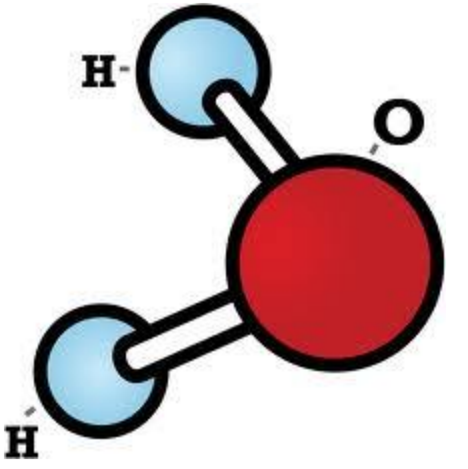
Inorganic

Lesson 2

- Properties of Water

(during lab period)

Properties of Water

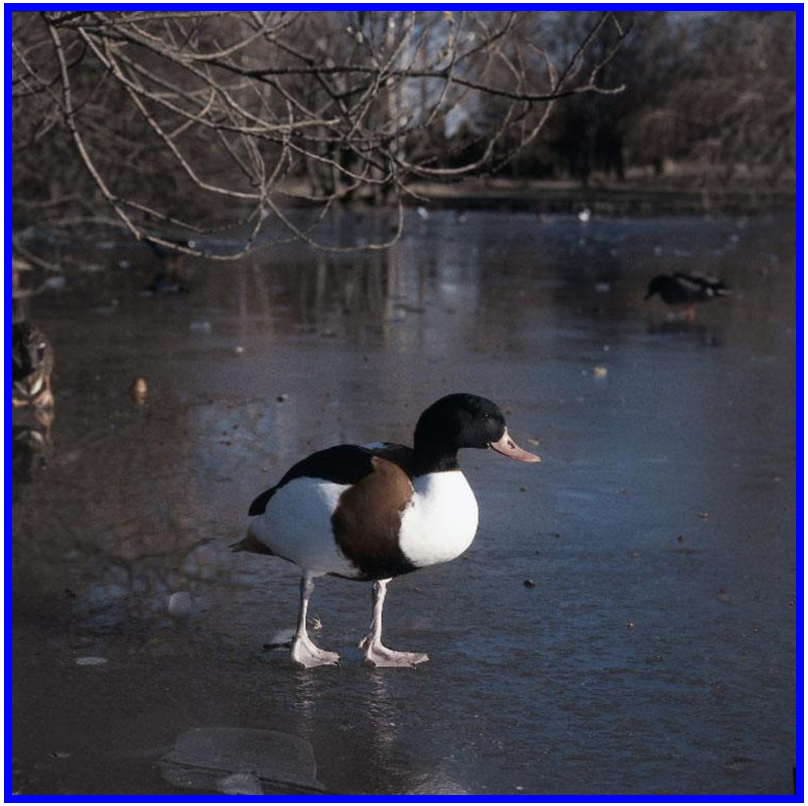


True or False????

1) Water contracts when it freezes
2) It is possible to walk on water
3) Condensation is water coming out of the air
4) Water is a basic (alkaline) substance
5) Ice sinks because it is very dense
6) Water is a compound composed of 3 atoms
7) Water is organic
8) Water is the most common compound on earth
9) Rainwater is the purest form of water
10) It takes more energy to heat cold water to boiling, than it does to change boiling water to steam
11) Falling raindrops are tear-shaped
12) Water Boils and evaporates faster at high altitudes
13) Water is the only substance that is found naturally on earth in all 3 states: solid, liquid, gas
14) The water we drink cannot be broken down or made. It has stayed the same since the beginning of time and has been used and reused by all organisms

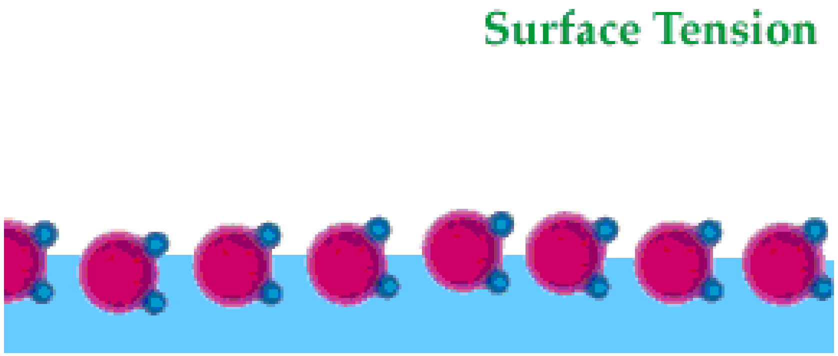
(1)Water contracts (gets smaller) when it freezes.

False



Water expands when it freezes!

(2) It is possible to walk on water

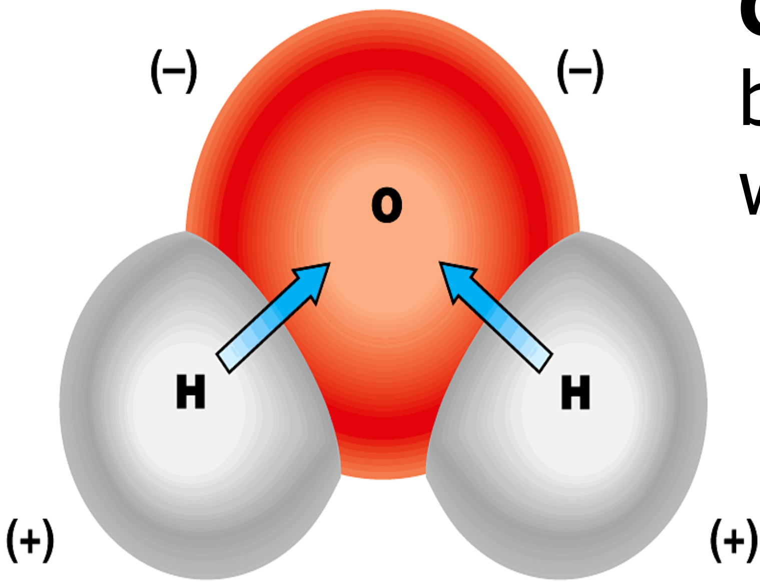


TRUE!

Hydrogen bonds form between water molecules allowing "***cohesion,***" causing water to have a strong ***"surface tension".***

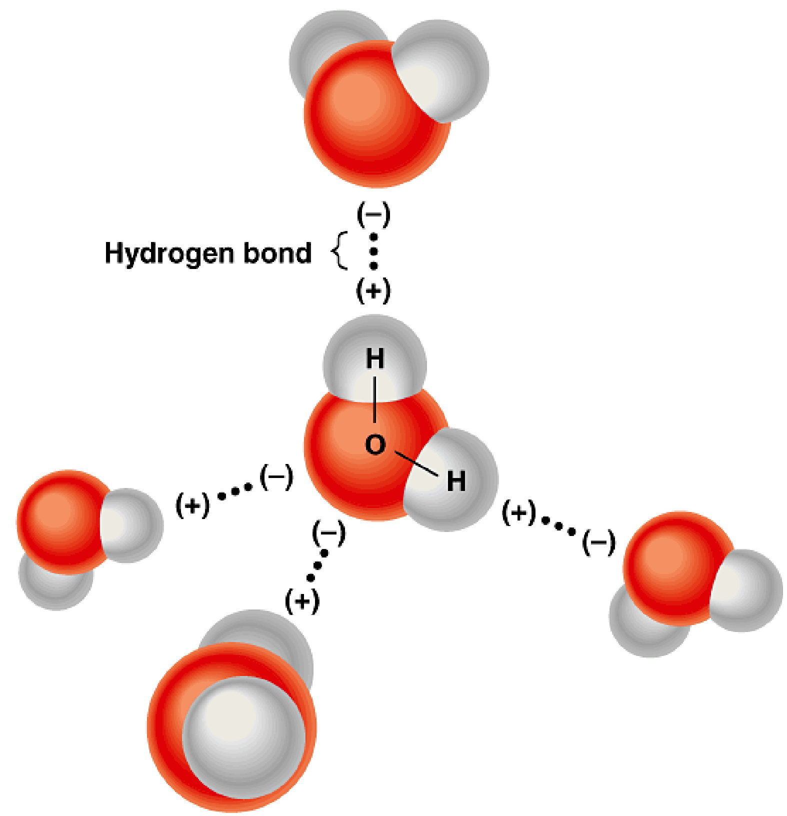
Cohesion …

[Basilisk Lizard - YouTube]



Covalent Bonds exist between the atoms within the water molecule

Hydrogen Bond



The ***hydrogen*** of one water molecule is attracted to the ***oxygen*** of another water molecule like opposite poles of a magnet are!

(3) Condensation is water coming out of the air.

True

When *water vapor* cools it takes up less space and contracts, allowing *water* molecules to stick to one another forming clouds and precipitation.

4) Water is a basic (alkaline) substance

False

Pure water has a neutral pH (potential Hydrogen ion concentration)

pH of water = 7

1/10,000,000	14	Liquid drain cleaner, Caustic soda	Examples of so and their respec
1/1,000,000	13	bleaches, oven cleaner	
1/100,000	12	Soapy water	
1/10,000	11	Household Ammonia (11.9)	
1/1,000	10	Milk of magnesium (10.5)	
1/100	9	Toothpaste (9.9)	
1/10	8	Baking soda (8.4), Seawater, Eggs	
0	7	"Pure" water (7)	
10	6	Urine (6) Milk (6.6)	
100	5	Acid rain (5.6) Black coffee (5)	
1,000	4	Tomato juice (4.1)	
10,000	3	Grapefruit & Orange juice, Soft drink	
100,000	2	Lemon juice (2.3) Vinegar (2.9)	
1,000,000	1	Hydrochloric acid secreted from the stomach lining (1)	
10,000,000	0	Battery Acid	

Acid and Base Properties

Acid Properties:

When dissolved in water, acids

1. Conduct electricity
2. Change blue litmus to red
3. Have a sour taste
4. React with bases to neutralize their properties
5. React with active metals to liberate hydrogen.

Base Properties:

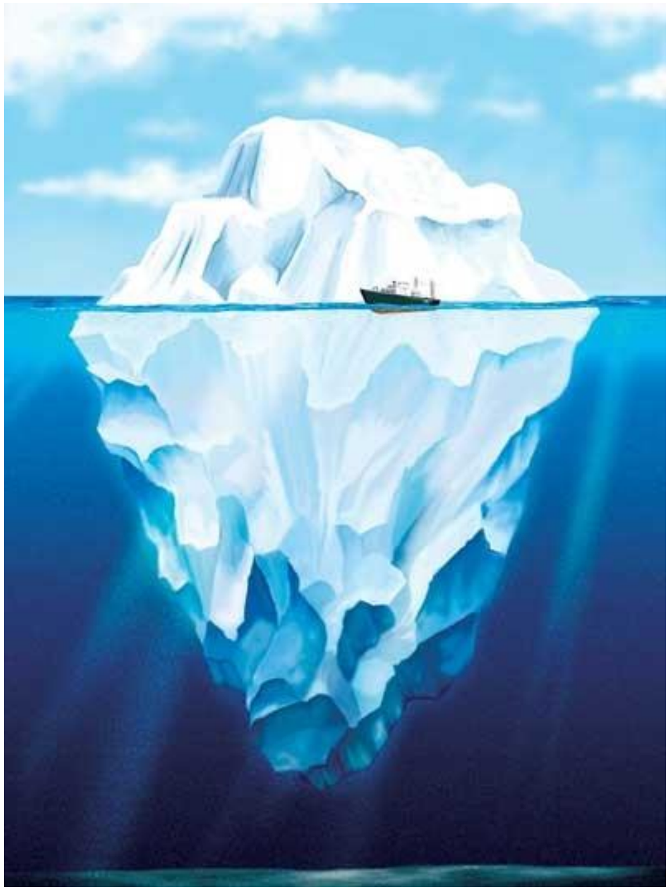
When dissolved in water, bases

1. Conduct electricity
2. Change red litmus to blue
3. Have a slippery feeling
4. React with acids to neutralize their properties.

5) Ice sinks because it is very dense

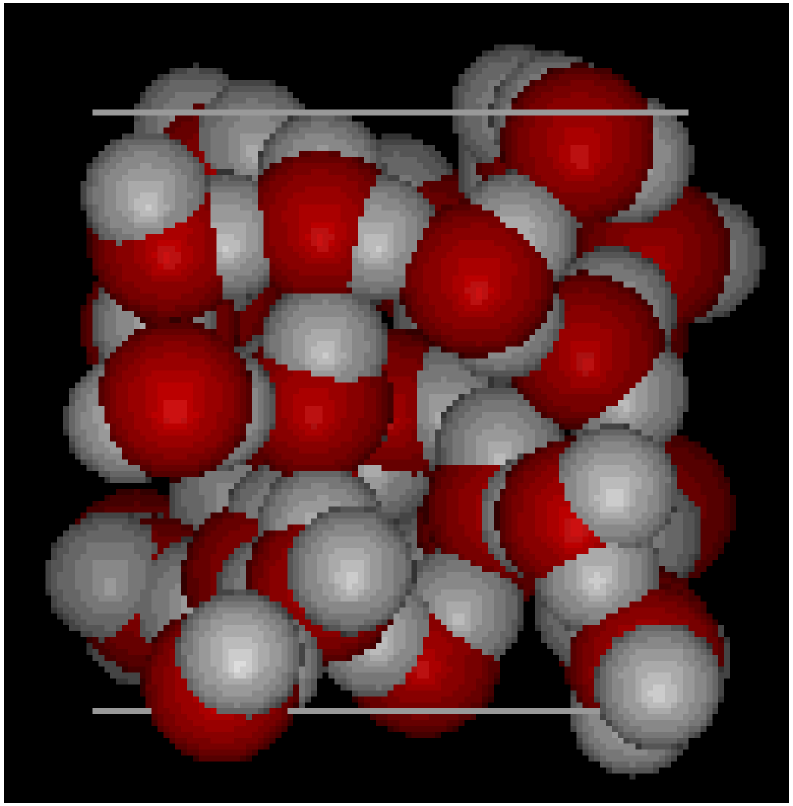
FALSE!

Ice is less dense than water so it floats!

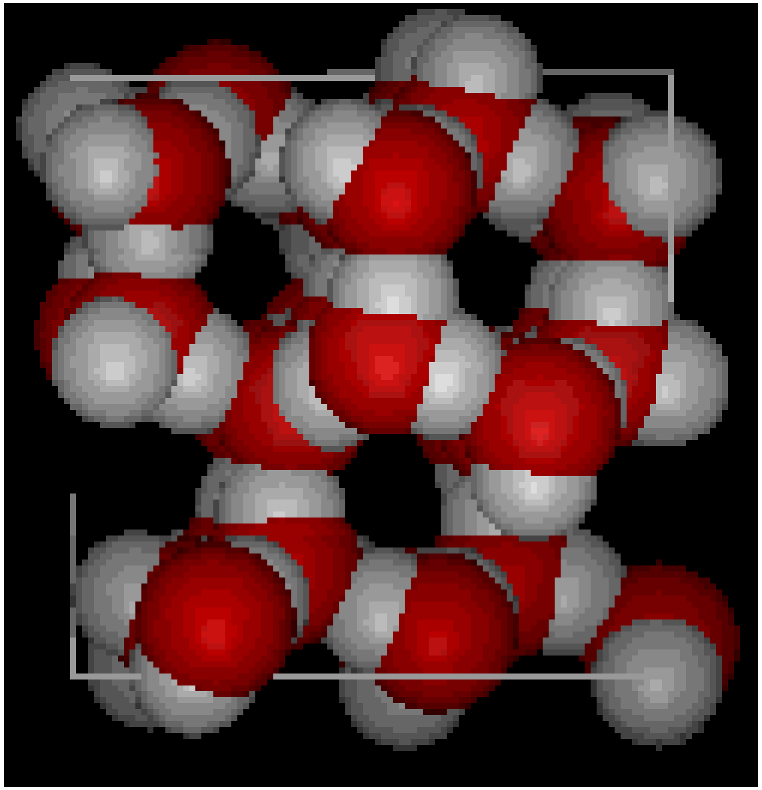


Water is Less Dense as a Solid

Water



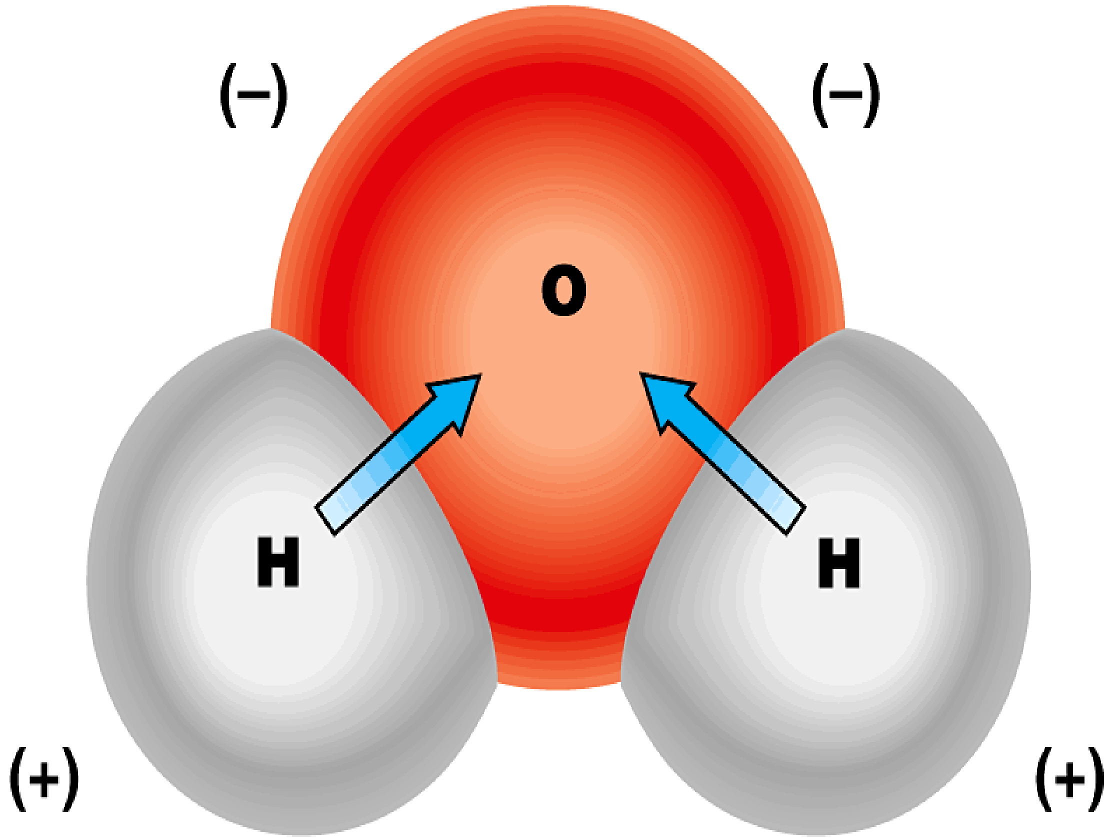
Ice



6) Water is composed of 3 atoms!

TRUE!

Water is made from 2 hydrogen atoms covalently bonded to one oxygen atom!

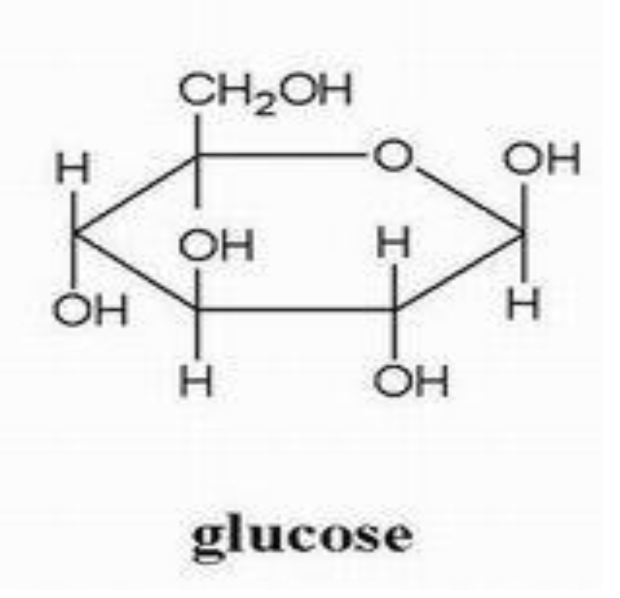


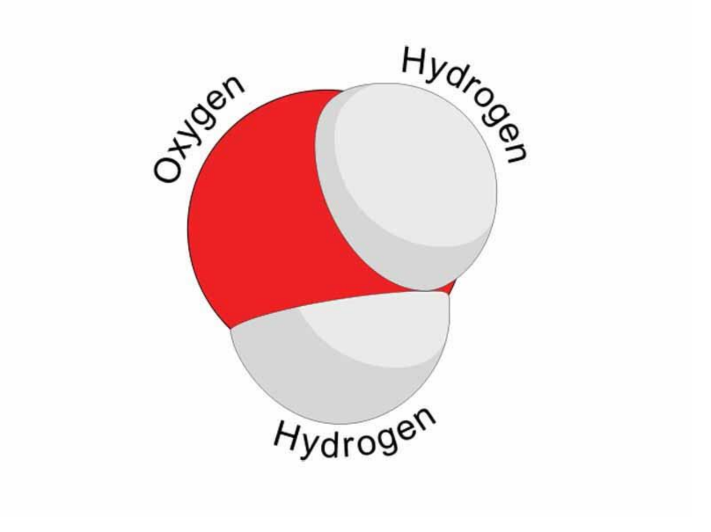
7) Water is ORGANIC

FALSE!

Water is ***In***organic!

<u>Molecules must have both **Carbon AND Hydrogen** to be ORGANIC!</u>





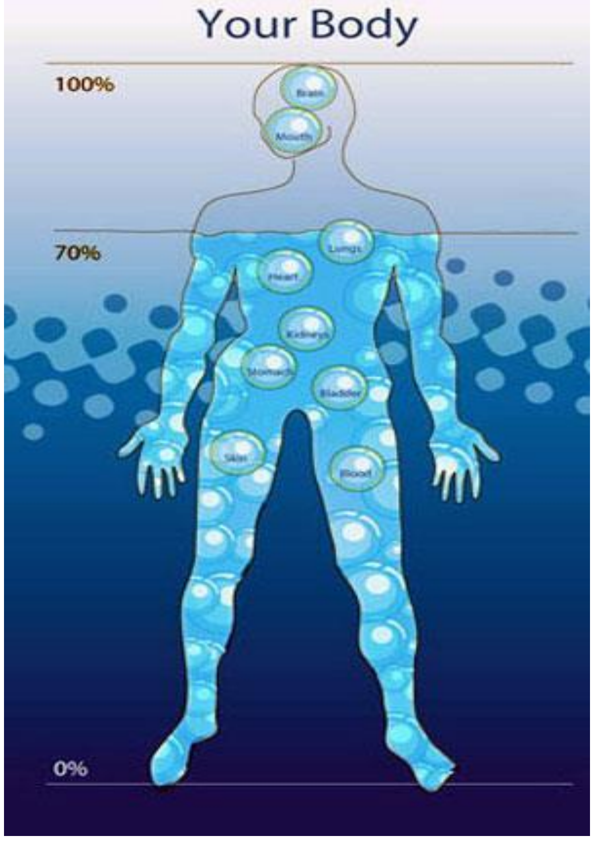

INORGANIC
Oxygen rules
this domain
ORGANIC
Carbon rules
this domain

8) Water is the most common compound on Earth.

True

More then <u>70% of the Earth is *water*</u>.

<u>66% of our bodies are made of *water*</u>.



[- Water Structure and Hydrogen Bonding - YouTube]

9) Rainwater is the purest form of water.

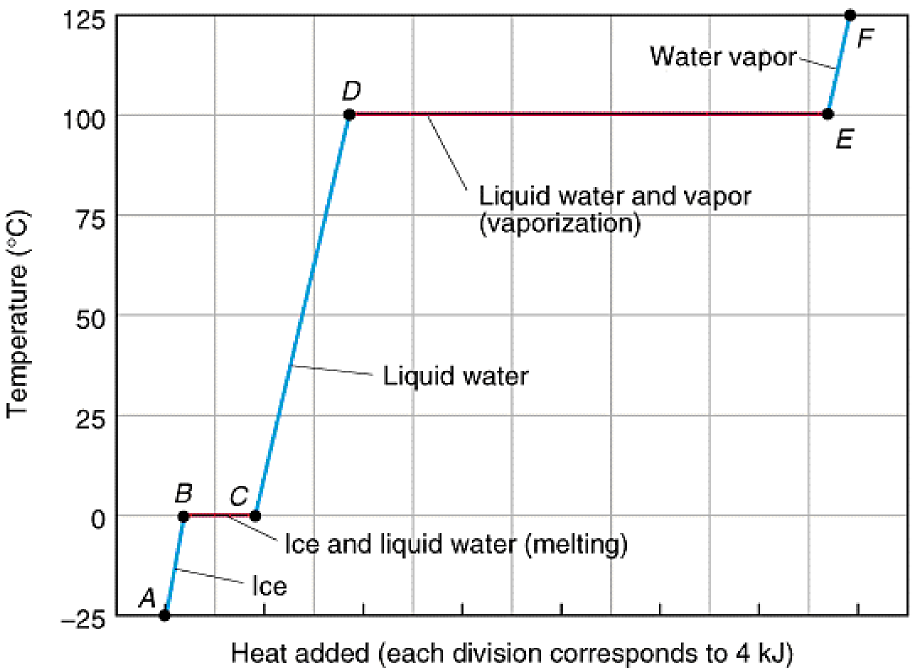
False

Precipitation of any kind (*snow, rain, hail*) contains dissolved minerals, gasses, acids, dust, pollen grains, viruses and microorganisms!

Distilled *water* is the purest! (But don't drink it!)

10) It takes more energy to heat cold water to boiling, than it does to change boiling water to steam

False



!

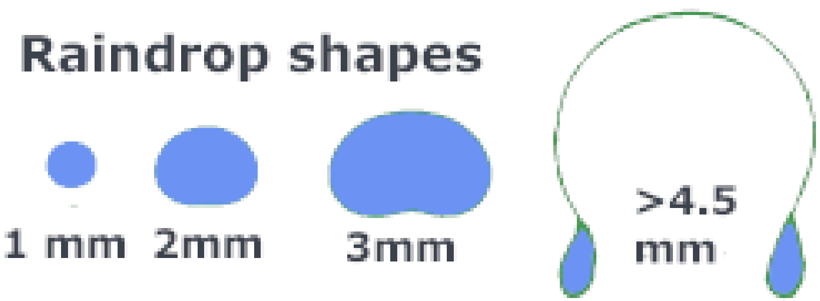
It takes 5x more energy to turn boiling *water* into steam than to raise cool *water* to boiling point @ 212º F .

- ☆ Water has a HIGH SPECIFIC HEAT

  Water has a HIGH HEAT of VAPORIZATION!

11) Falling raindrops are tear-shaped.

False

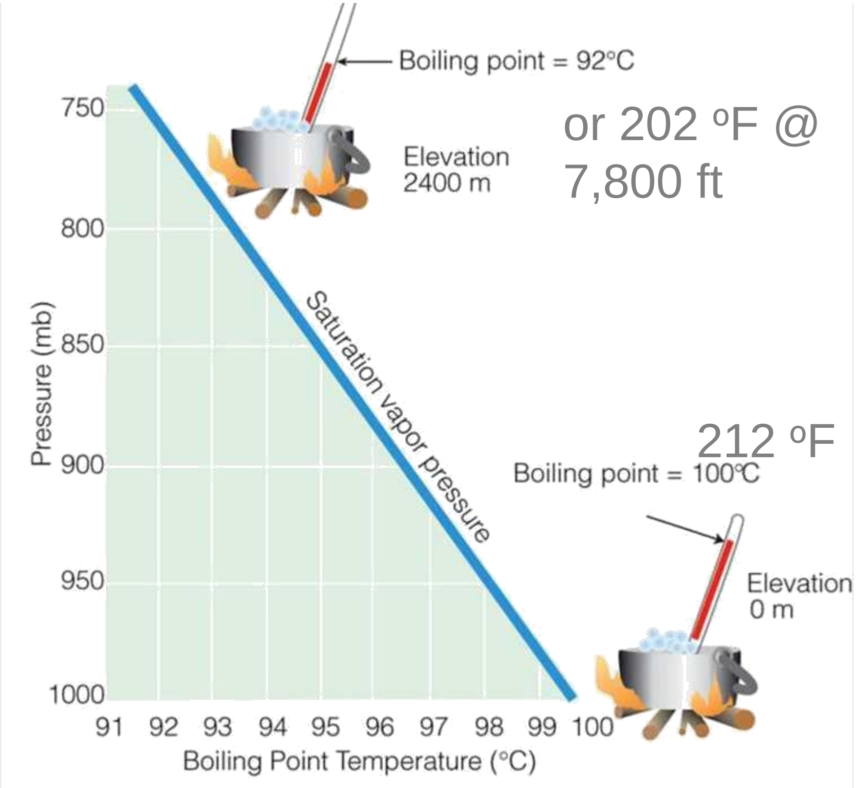


A drop of ***water*** coming out of a faucet, does have a tear shape… until it can't hold on any more. But when it falls it look more like a small hamburger bun due to the interplay between ***gravity*** and ***surface tension***. <u>As a drops falls, the air below the drop pushes up from the bottom, causing the drop to flatten out somewhat.</u>

12) Water boils & evaporates quicker at high altitudes

True

At sea level ***water*** boils at 100° C. At 2,400 m, ***water*** boils at 92° C. This is because as the altitude gets higher, the lower air pressure makes it easier for the ***water*** molecules to break their bonds thus, it boils more easily.

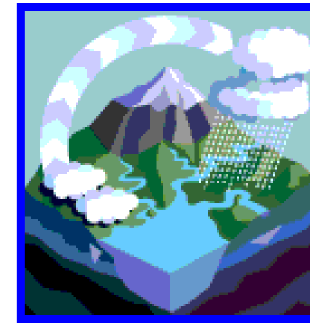


13) Water is the only substance that is found naturally on earth in three states: liquid, gas, solid.

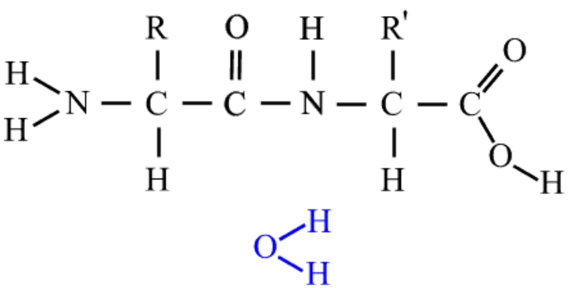
True

Water can commonly be seen in the solid, liquid and gaseous state on Earth.

14) The water we drink cannot be broken down or made. It has essentially stayed the same since the beginning of time, and has been used and reused by all life forms!



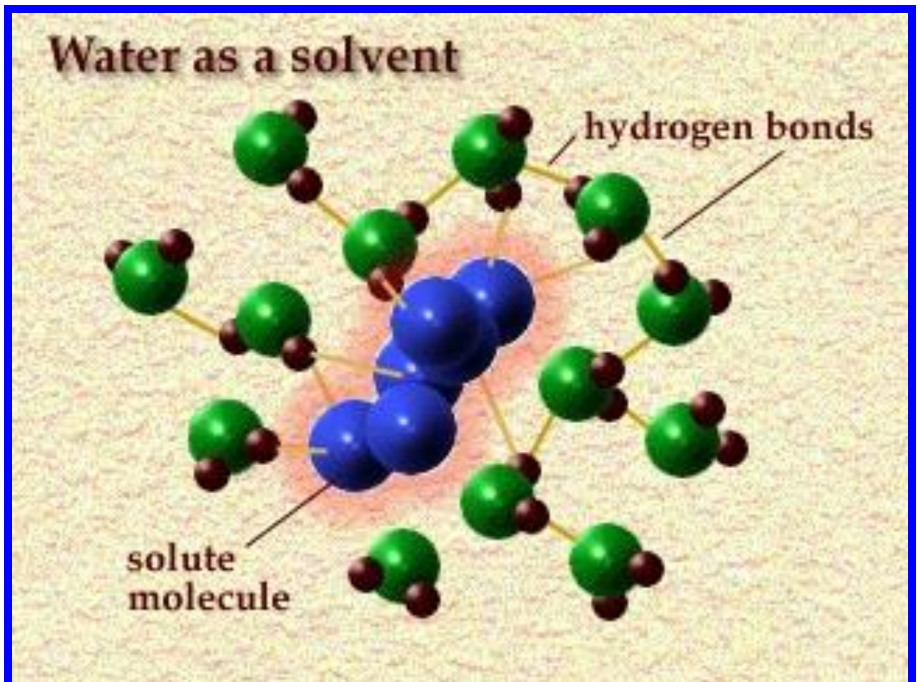
True & False



<u>Water must be added in order to break bonds, and taken away in order to create bonds!</u>

Water is known as the universal ___________.

solvent



A substance that has the ability to dissolve both bases and acids, such as *water* is called a “universal solvent. Everything else dissolves in *water* as well... stone, iron, pots, pans, plates, sugar, salt, and coffee beans.

Adhesion Causes Capillary Action

Which gives water the ability to "climb" structures

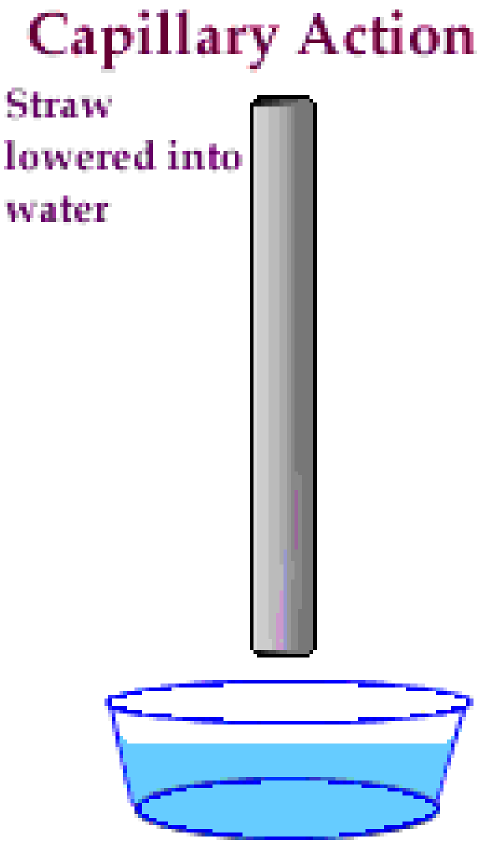
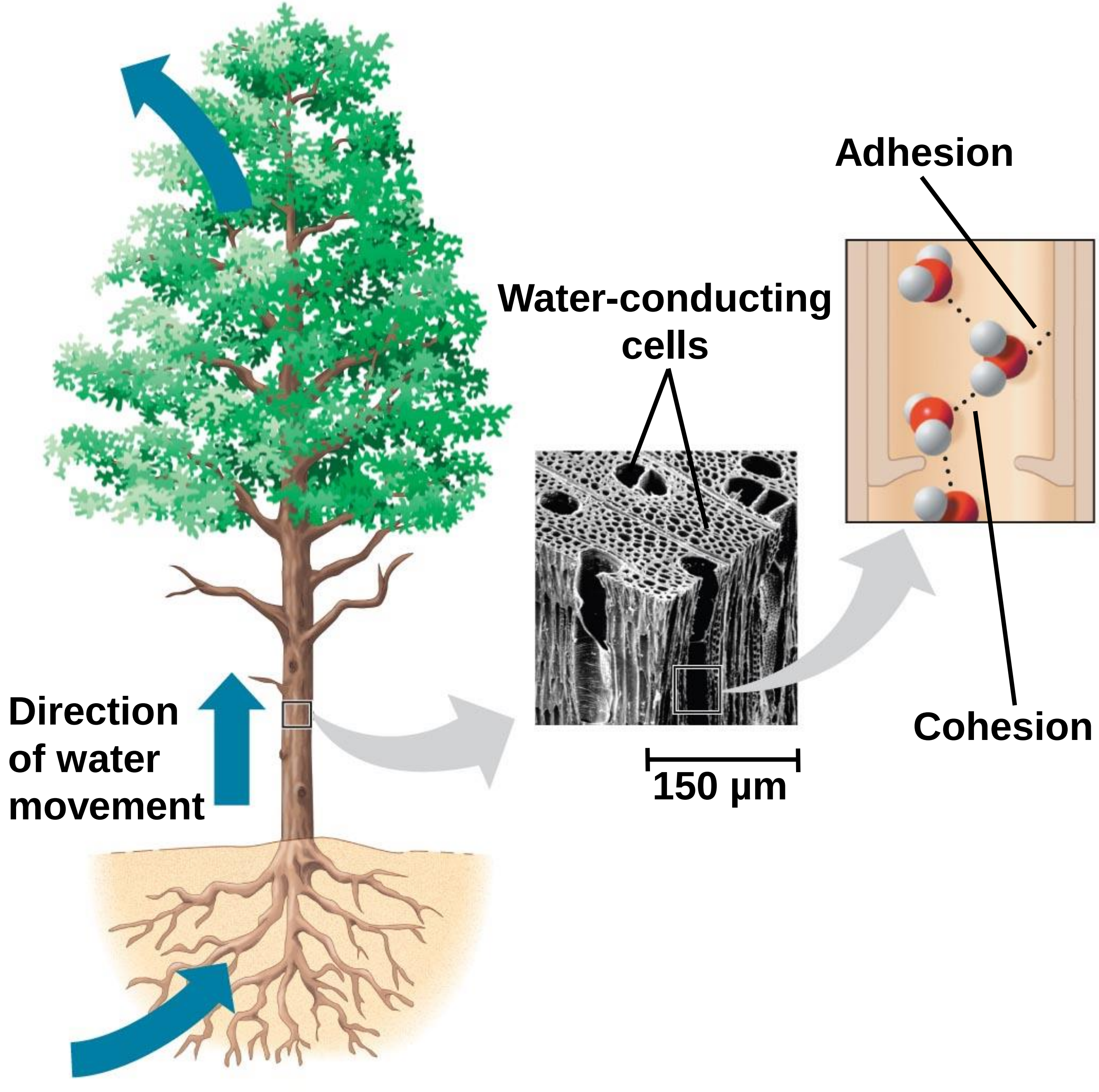


Fig. 3-3


Adhesion
Water-conducting
cells
Direction
of water
movement
150 µm
Cohesion

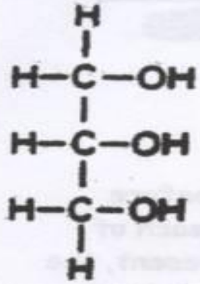
Lesson 3

- Nutrients (Macromolecules)
  - Carbohydrates

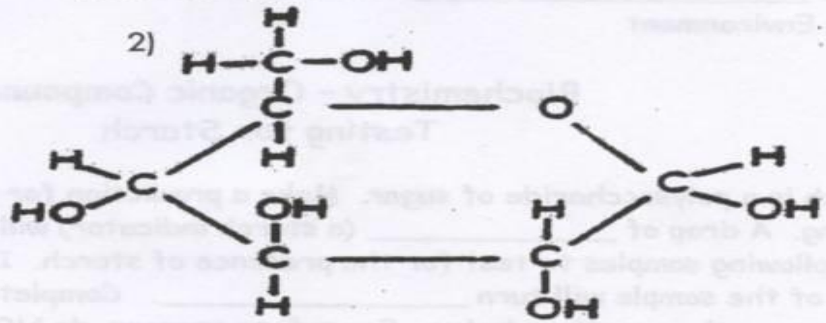
Name ____________________

Organic or Inorganic?
That is the question.

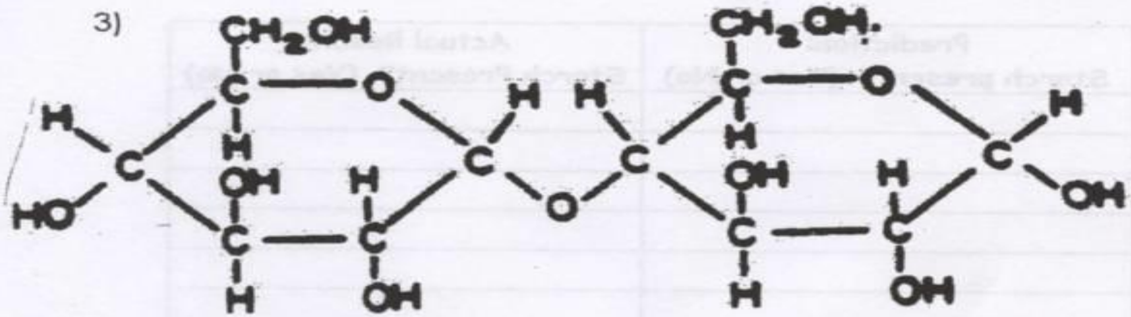
1)



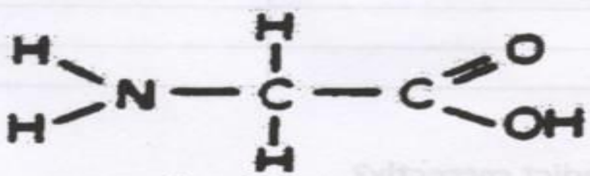
2)



3)



4)



Directions:
1.Circle whether the molecule is organic/inorganic. 2.Record the number of Carbons, Hydrogens, and Oxygens, in the space provided. 3.Write "yes" if the molecule is a carbohydrate, "no" if it is not a carbohydrate.

1) organic / inorganic

carbons __________
hydrogens ________
oxygens __________
carbohydrate? __________

2) organic / inorganic

carbons __________
hydrogens ________
oxygens __________
carbohydrate? __________

3) organic / inorganic

carbons __________
hydrogens ________
oxygens __________
carbohydrate? __________

4) organic / inorganic

carbons __________
hydrogens ________
oxygens __________
carbohydrate? __________

Testing for Starch Activity

Starch is a polysaccharide of sugar. Make a prediction for each sample before testing. A drop of ____**Iodine**____ (a starch indicator) will be added to each of the following samples to test for the presence of starch. If starch is present, the color of the sample will turn ____**black**____.

Sample:	Prediction: Starch present? (Yes or No)	Actual Result: Starch Present? (Yes or No)

Conclusion Questions:

1) How many samples did you predict correctly?

2) Were there any samples containing starch that you predicted would *not* contain starch? Which ones?

3) Were there any samples *not* containing starch that you predicted *would* contain starch? Which ones?

4) If you wanted to perform this activity and test for glucose instead of starch, would you still use Iodine to test the samples? What would you use? (HINT: Think back to the state lab on Diffusion)

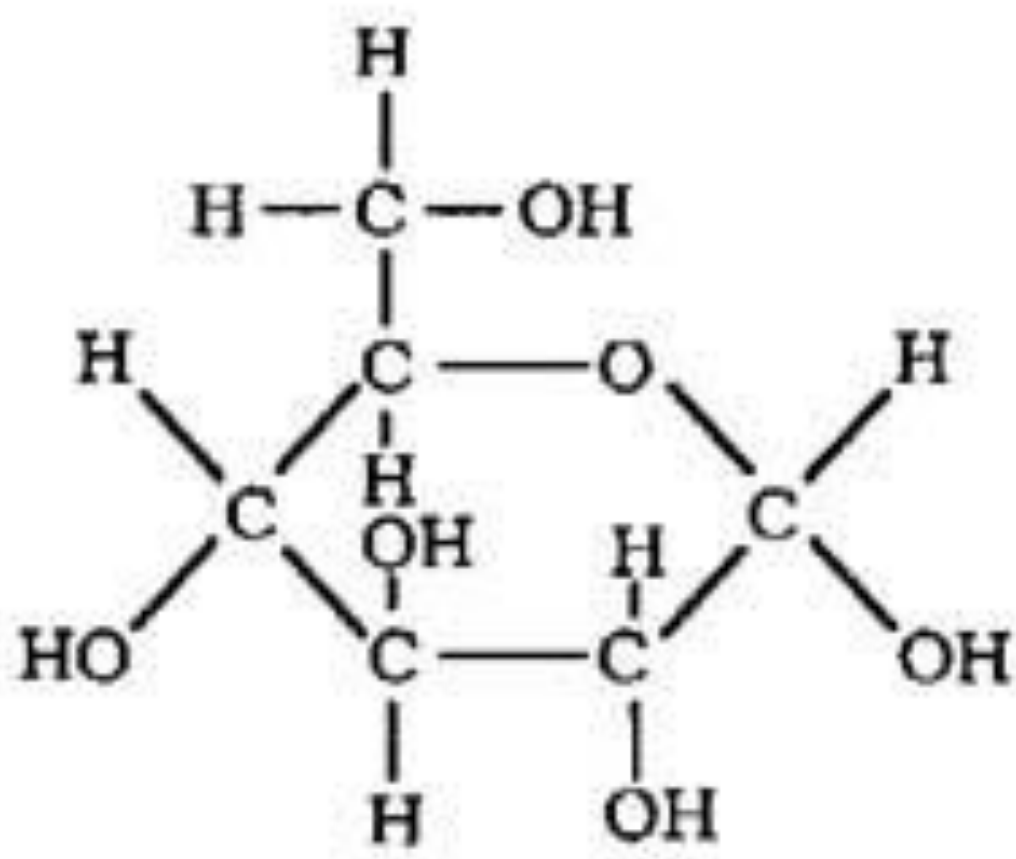
Characteristics	Carbohydrates
Elements	Carbon, Hydrogen, Oxygen
Ratio	H:O = 2:1
Building Blocks (Monomers → Polymers)	Monosaccharides (simple sugars) ex. Glucose → Polysaccharides (starch)
Functions	•MAIN source of <u>ENERGY</u> for cells •Also used for structural purposes (plant cell walls made of cellulose)
Examples and Structure	Starch- ex.Glycogen (animal) & cellulose (plant) Glucose ($C_6H_{12}O_6$) - monosaccharide Clue: Most sugars end in “ose”

Carbohydrates (con't)

Structural Diagram

Glucose (monosaccharide)

$C_6H_{12}O_6$



Starch is classified as a

a. disaccharide

b. polypeptide

C. nucleotide

d. polysaccharide

Good Sugars and Bad Sugars

- Blood Sugar: The Link To Cancer, Heart Attacks, and other preventable diseases. - YouTube

Lesson 4

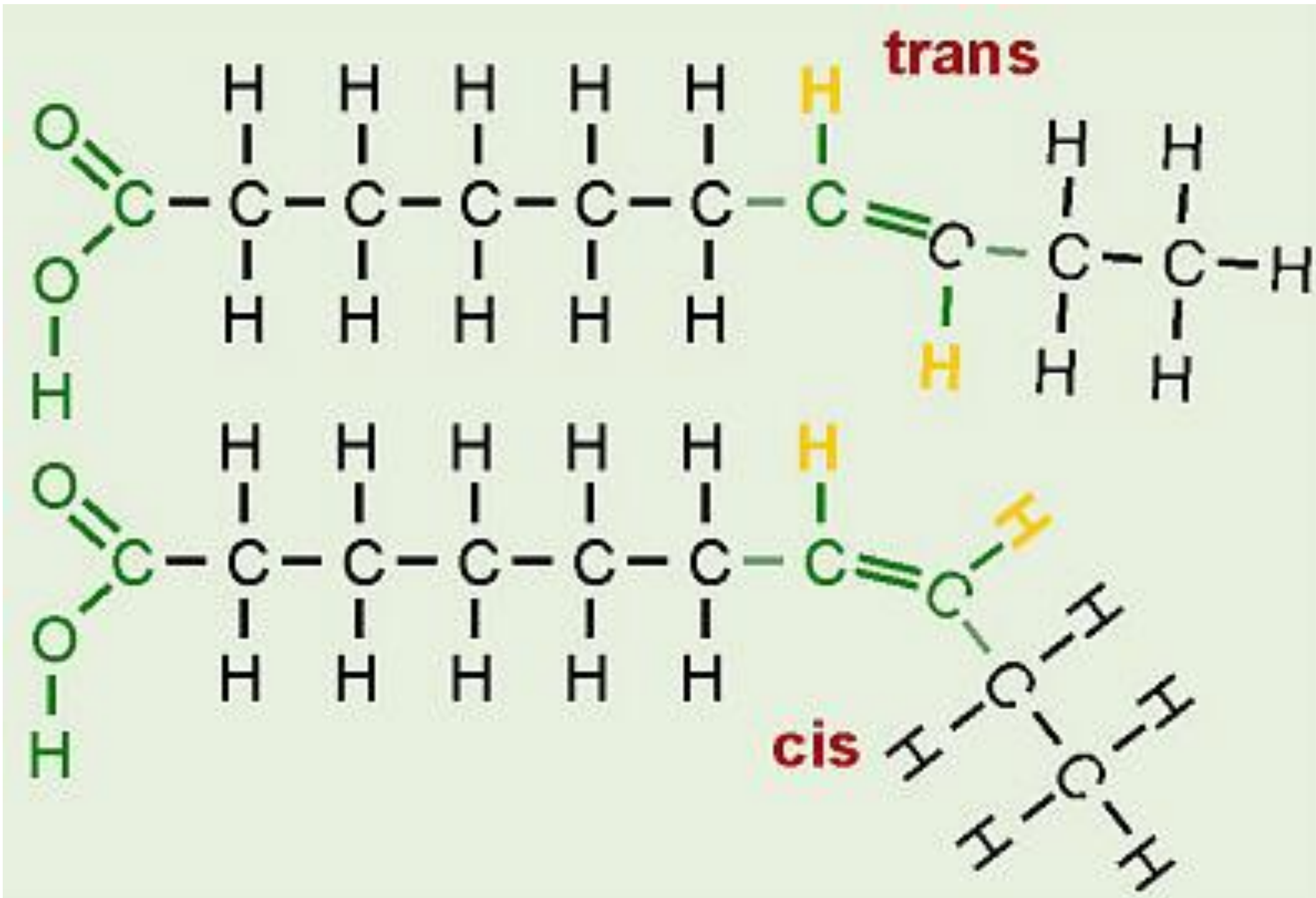
- Nutrients (Macromolecules)
  - Lipids

Good Fat vs. Bad Fat

- **Good:** We need a balance of omega-3 and omega-6 in order to maintain healthy cardiac function, mood stability, insulin balance, joint health and skin health. We need to keep the intake of these good fats balanced because they work in opposition to each other. Too much of one type of fat and not enough of the other can cause a variety of problems. For example, too much omega-6 can cause problems such as degenerative and inflammatory diseases.
- Our bodies do not make good fats; we can only get them in food. Omega-3 is found in fish and fish oil, all green leafy vegetables, walnuts. Omega-6 is found in corn oil and other vegetable oils such as safflower oil. Surveys show that most people do not have enough omega-3 in their diet, while they have too much omega-6.
- Just as it is essential that our intake of good fats is balanced, we also need to get rid of the bad fats in our diet.

- **Bad:** In unsaturated fatty acids, there are two ways the pieces of the hydrocarbon tail can be arranged around a C=C double bond. In **cis bonds**, the two pieces of the carbon chain on either side of the double bond are either both up or both down, such that both are on the same side of the molecule. In **trans bonds**, the two pieces of the molecule are on opposite sides of the double bond, that is, one up and one down across from each other. Naturally-occurring unsaturated vegetable oils have almost all cis bonds, but using oil for frying causes some of the cis bonds to convert to trans bonds. If oil is used only once like when you fry an egg, only a few of the bonds do this so it's not too bad. However, if oil is constantly reused, like in fast food French fry machines, more and more of the cis bonds are changed to trans until significant numbers of fatty acids with trans bonds build up. The reason this is of concern is that fatty acids with trans bonds are **carcinogenic**, or cancer-causing.

Trans fat structure



- **You Eat More!** It's not like you have any choice in the matter. Remember that the essential fatty acids are vital to *every* metabolic function in your body. You *will* get the quantity of essential fatty acids that you need to sustain life, no matter what. You will not stop being hungry until you do.
- If you are consuming lots of saturated fats, you really have no choice but to become fat, because saturated fats contain only small quantities of the polyunsaturated fats that contain the essential fatty acids you need. The key to being thin, then, is to consume foods containing large amounts of polyunsaturated oils. (Those foods include fish, olives, nuts, and egg yolks.) Over the long term, those foods remove your sense of hunger.

- **Your Metabolism Slows!** Worse, most partially hydrogenated oil is partially hydrogenated *soybean* oil. That's a problem, because soybean oil depresses the thyroid--which lowers your energy levels, makes you feel less like exercising, and generally makes you fatter!
- Of course, soybeans have been used for centuries in the Orient--but mostly as the basis for soy sauce and tofu. Asians didn't have soy milk, soy burgers, soy this and soy that. Most of all, they never used concentrated *essence* of soybean, in the form of soybean oil. And they didn't hydrogenate it, and they didn't use it in *everything*.
- Walking down supermarket aisles in America, you find product after product with partially hydrogenated oil--often in products you would never expect. But why not? After all, it's cheaper than butter. And it's not illegal. Why not!??
- As a result, Americans are consuming soybean oil--partially *hydrogenated* soybean oil--in virtually everything they eat. It's no wonder that America is experiencing epidemic levels of diabetes, obesitiy, heart disease, and cancer.

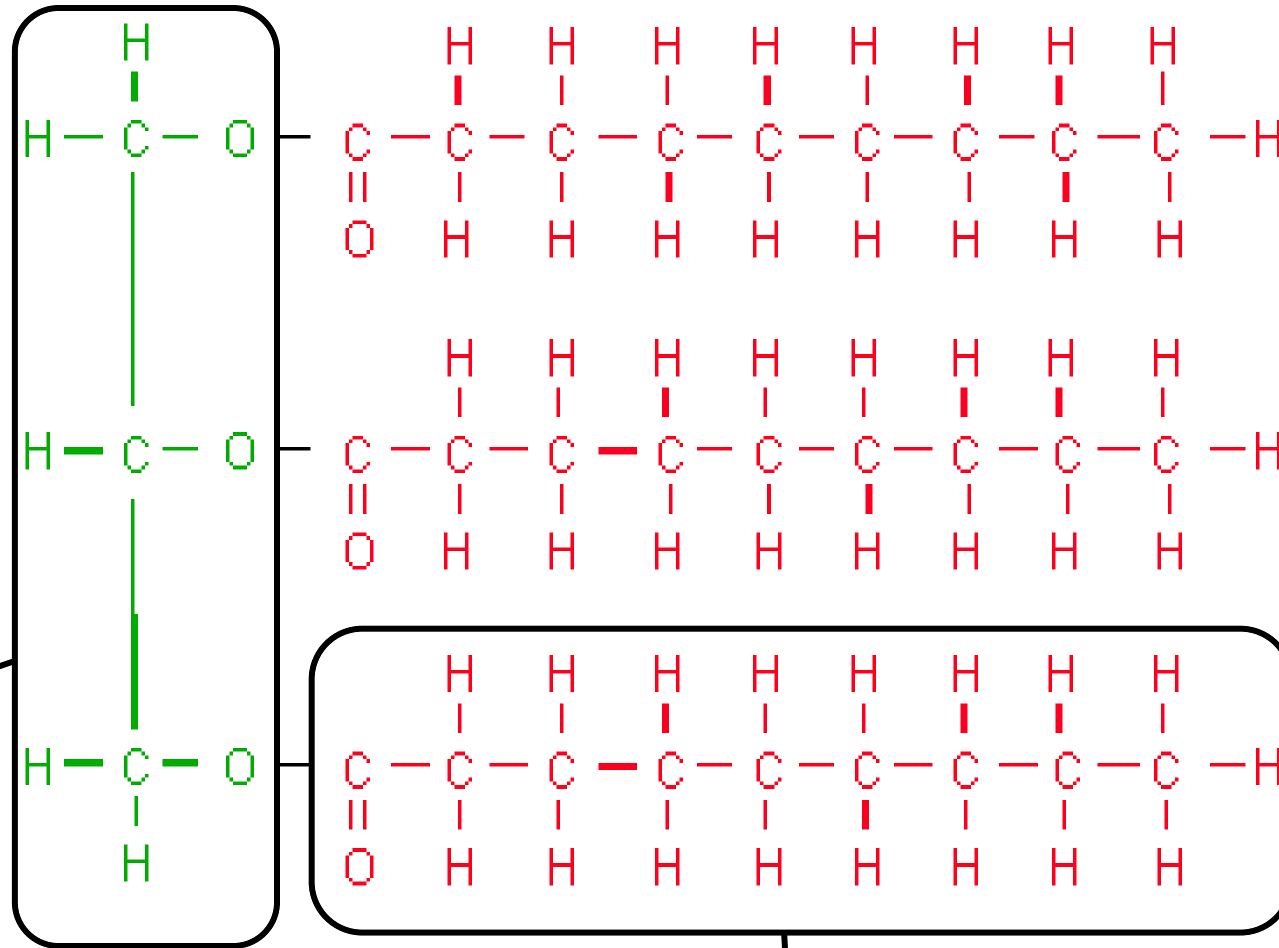
Characteristics	Lipids BRAINPOP
Elements	Carbon, Hydrogen, Oxygen
Ratio	H:O = greater than 2:1
Building Blocks (Monomers → Polymers)	3 fatty acids and 1 glycerol per lipid
Functions	•source of <u>STORED energy</u> for cells •structure of biological membranes •used in waterproof coverings
Examples and Structure	Fats, cholesterol, oils, waxes, steroids (chemical messengers) Saturated: has max # of H atoms Unsaturated: less than max # of H

Lipids (con't)

Structural Diagram

1 glycerol

3 fatty acids



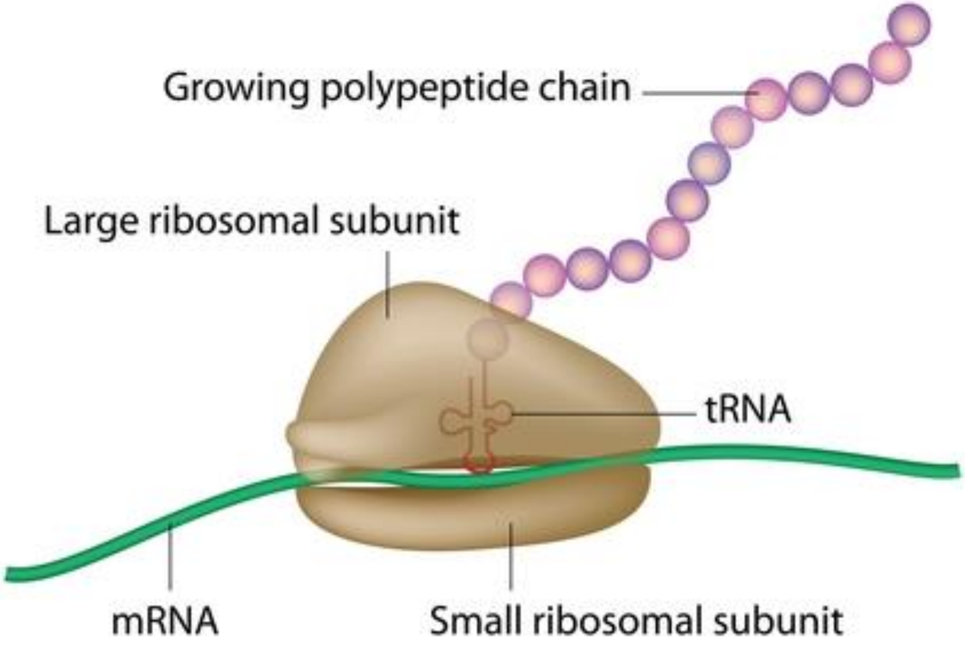
Glycerol (lipid head)

Fatty acid (lipid tail)

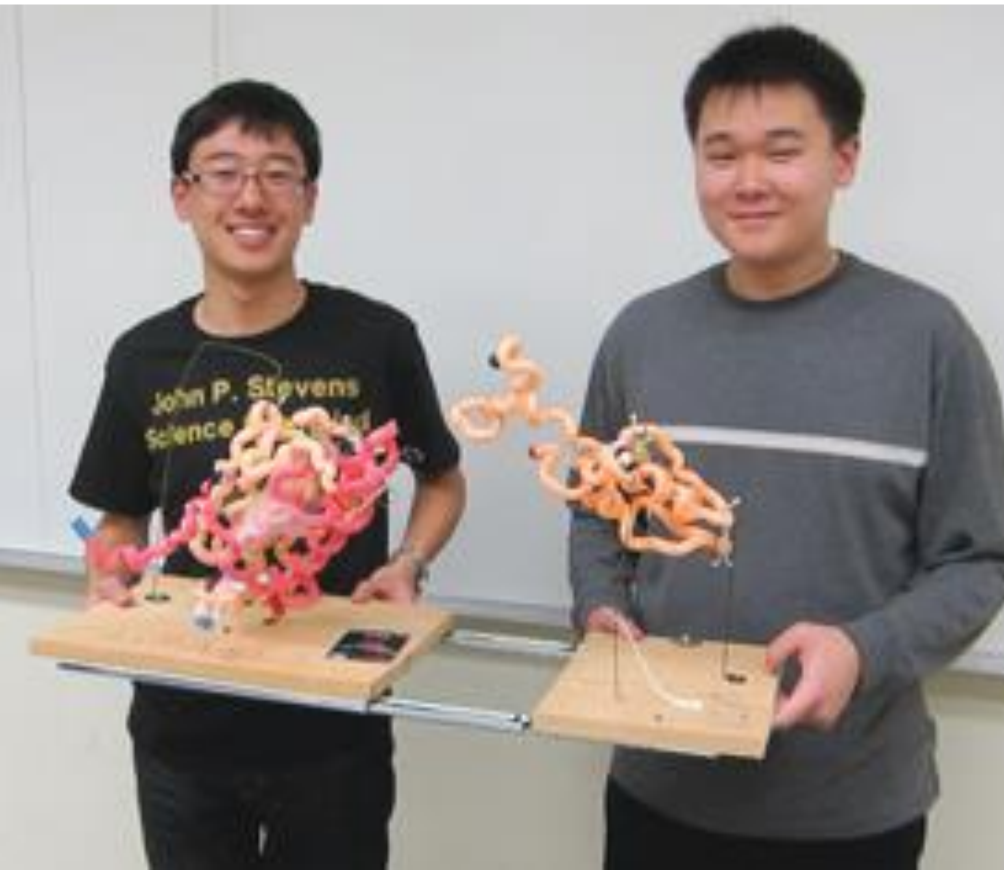
Lesson 5

- Nutrients (Macromolecules)
  - Proteins

What do you already know about **PROTEINS**?



Protein Modeling



How many different **LETTERS** are there in the English alphabet?

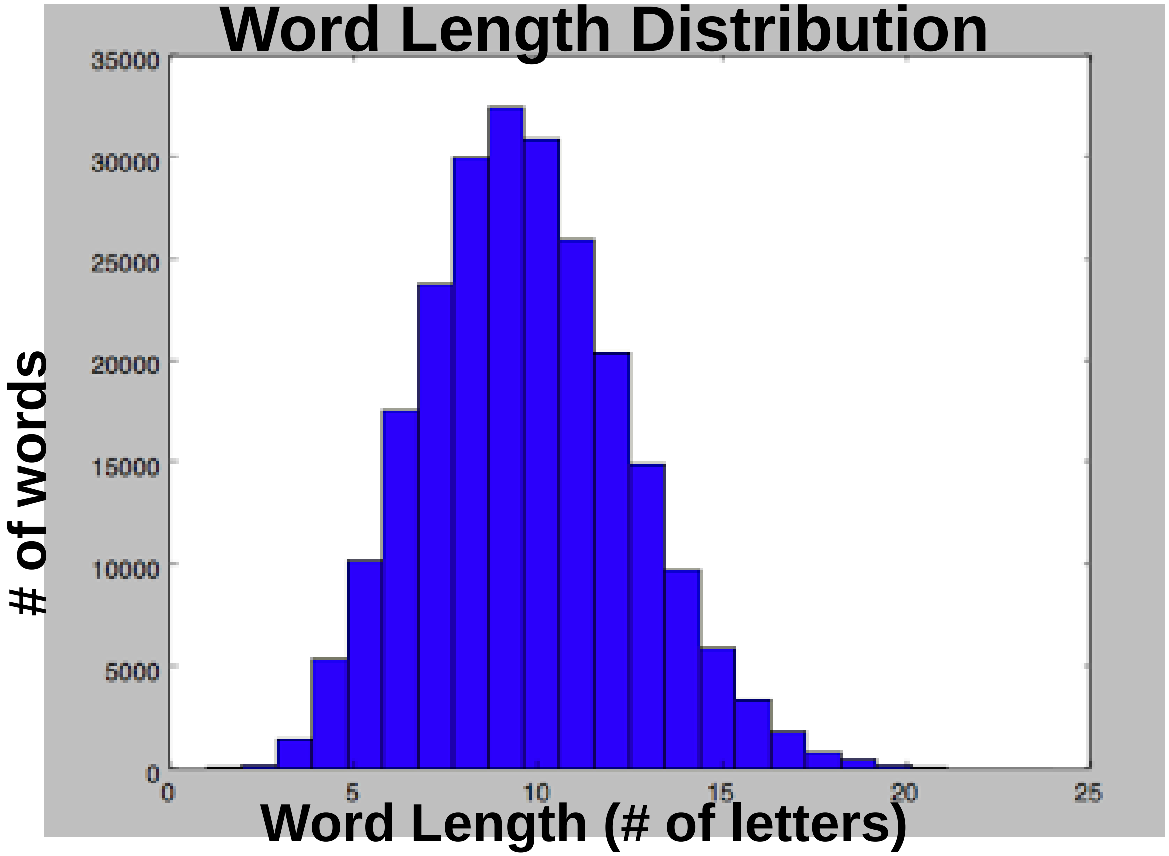
26

How many different **WORDS** can we spell from those 26 letters?

Over 1 million!

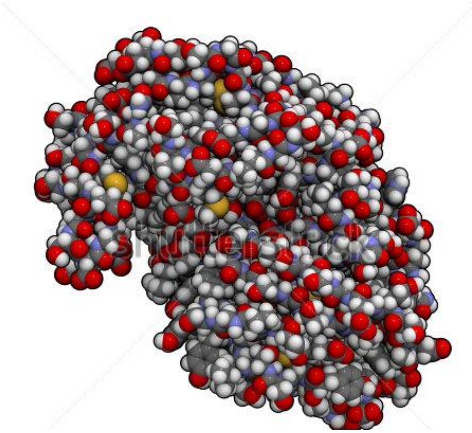
How is it possible to make **over 1 million <u>words</u>** out of only **26 <u>letters</u>**?

- Letters are used more than once in a word
- Words vary in size

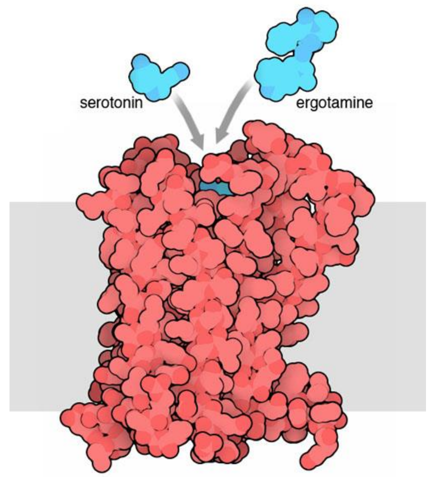


How many different **PROTEINS** exist in living things?

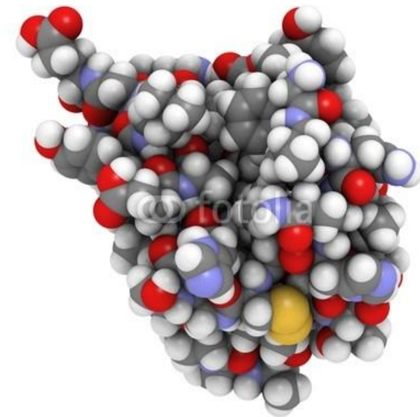
over 10 million!



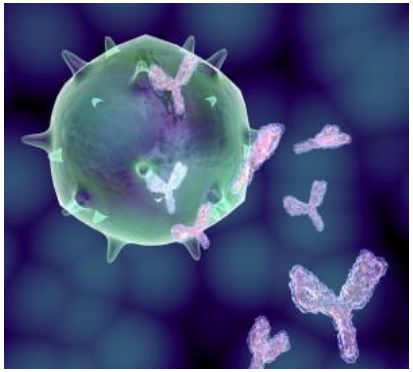
Enzyme Pepsin



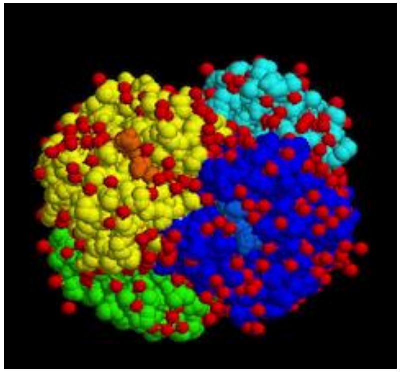
Receptor Molecule



Hormone Insulin



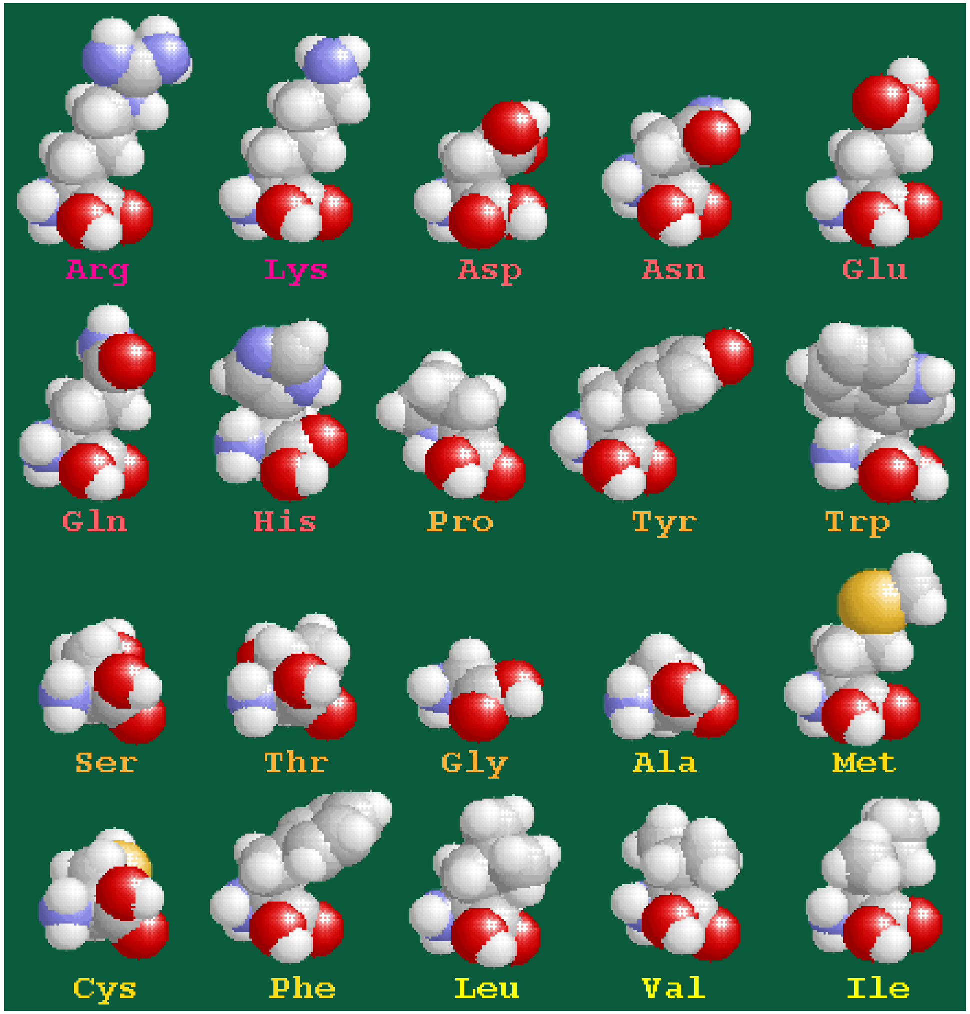
Antigens & Antibodies



Hemoglobin

How many different **building blocks of proteins** are there? **20!**

They are called **AMINO ACIDS**



So how is it possible to make over 10 million **PROTEINS** out of only 20 **AMINO ACIDS**?

- Amino acids are used more than once in a protein
- Proteins vary in size (can be very long)

Complete the following analogy:

Words are made up of letters like

___**Proteins**___ are made up of ___**Amino Acids**___!

Why is <u>sequencing</u> important?

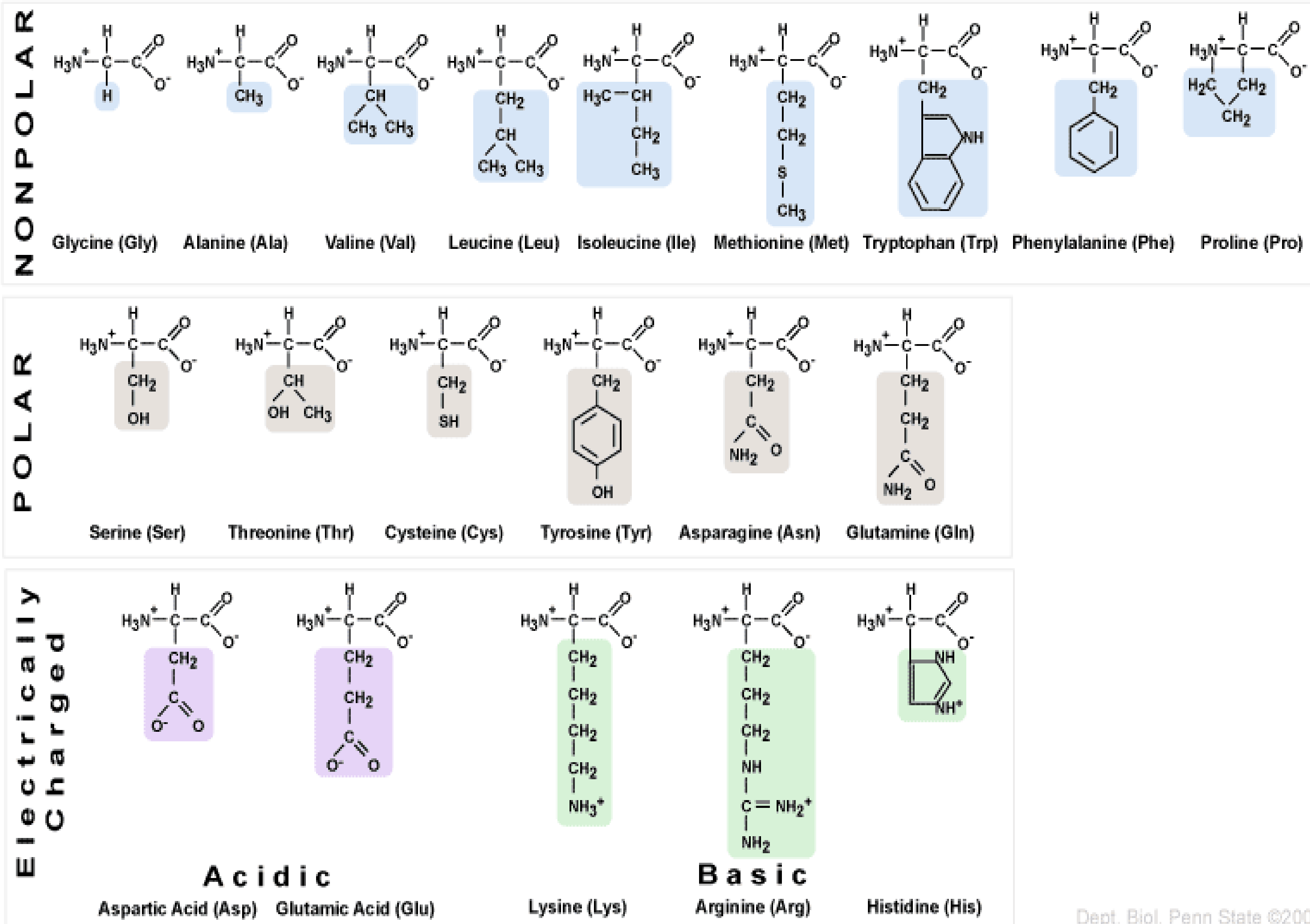
How do you spell  ?

C A T

What happens to the meaning of the word if the order of letters is changed?

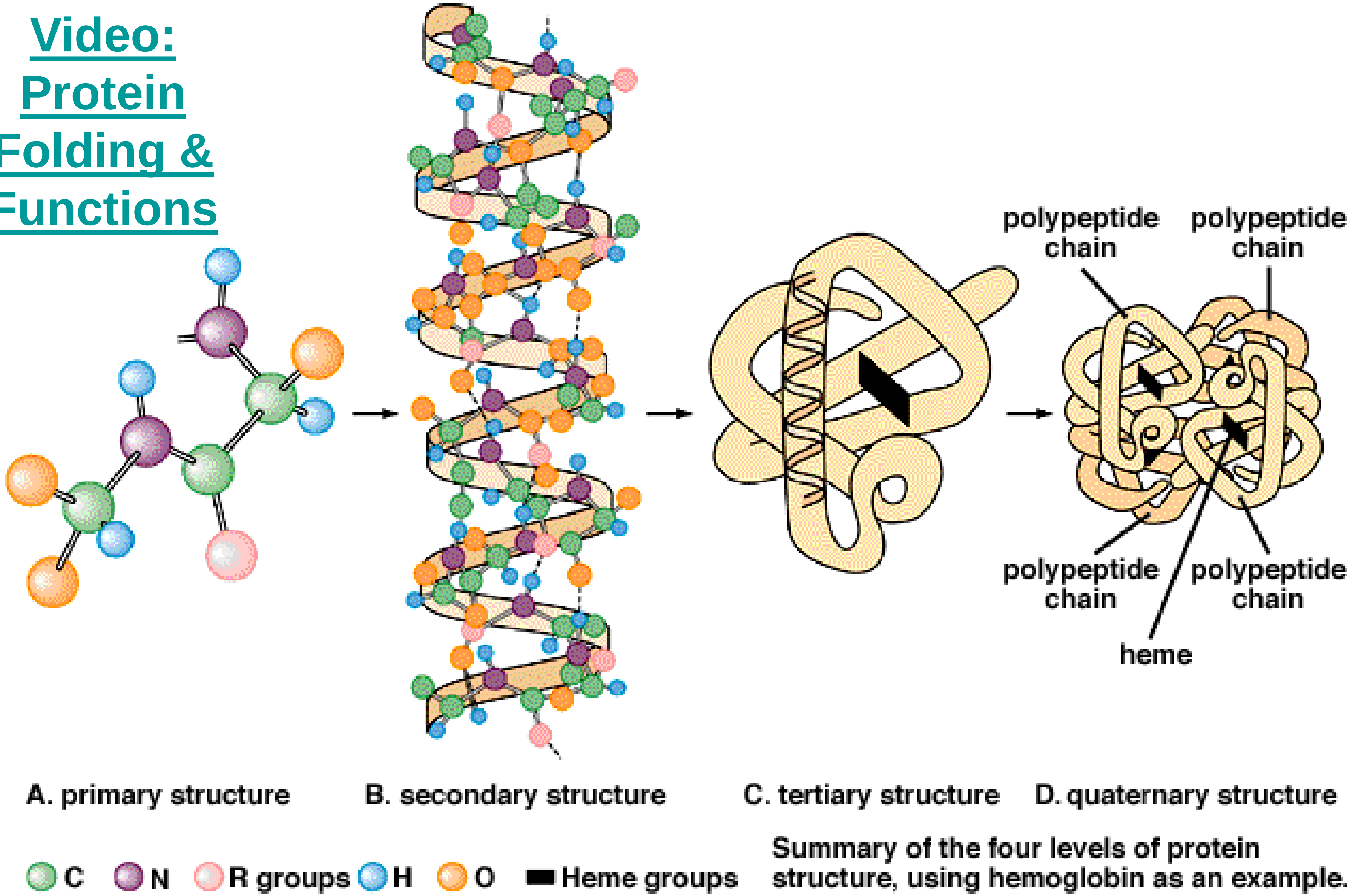
A C T

If the <u>order of amino acids</u> changes, so does the <u>structure and function</u> of the protein!


NONPOLAR
Glycine (Gly)
Alanine (Ala)
Valine (Val)
Leucine (Leu)
Isoleucine (Ile)
Methionine (Met)
Tryptophan (Trp)
Phenylalanine (Phe)
Proline (Pro)
POLAR
Serine (Ser)
Threonine (Thr)
Cysteine (Cys)
Tyrosine (Tyr)
Asparagine (Asn)
Glutamine (Gln)
Electrically Charged
Acidic
Aspartic Acid (Asp)
Glutamic Acid (Glu)
Basic
Lysine (Lys)
Arginine (Arg)
Histidine (His)
Dept. Biol. Penn State ©2002

The Four Levels of Protein Structure

Video: Protein Folding & Functions



Summary of the four levels of protein structure, using hemoglobin as an example.

Characteristics	Proteins
Elements	Carbon, Hydrogen, Oxygen, Nitrogen, sometimes Sulfur
Ratio	None
Building Blocks (Monomers → Polymers)	Amino acids (20 kinds) Arrange to form many different proteins
Functions	Each has a specific role, determined by its specific shape & sequence of amino acids! 1. Control rates of reactions (enzymes) 2. Form structures (ex. muscle & bone) 3. Transport substances in/out of cells 4. Send & detect chemical messages

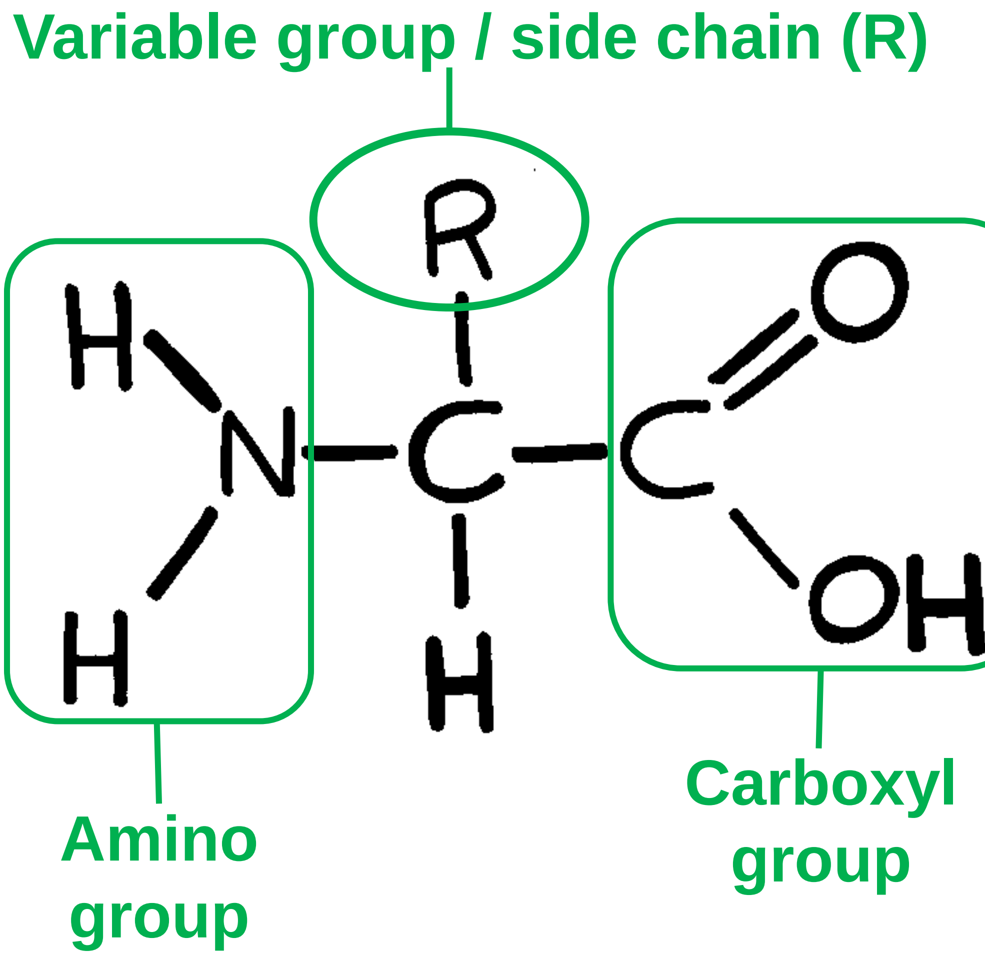
Proteins (con't)

Examples and Structure	hormones, enzymes, receptors, antibodies, membrane carrier proteins, hemoglobin - Peptide bonds join amino acids - Dipeptide = 2 amino acids joined - Polypeptide = many peptide bonds

Proteins (con't)

Structural Diagram

Amino acid



Review of Proteins

Amino acids have an __amino group__ at one end and a __carboxyl group__ (acid group) at the other end. A __variable group__ represented by the letter R is bonded to one of the carbons. There are (#) __20__ different amino acids found in living things. All amino acids are alike except they have a different R group.

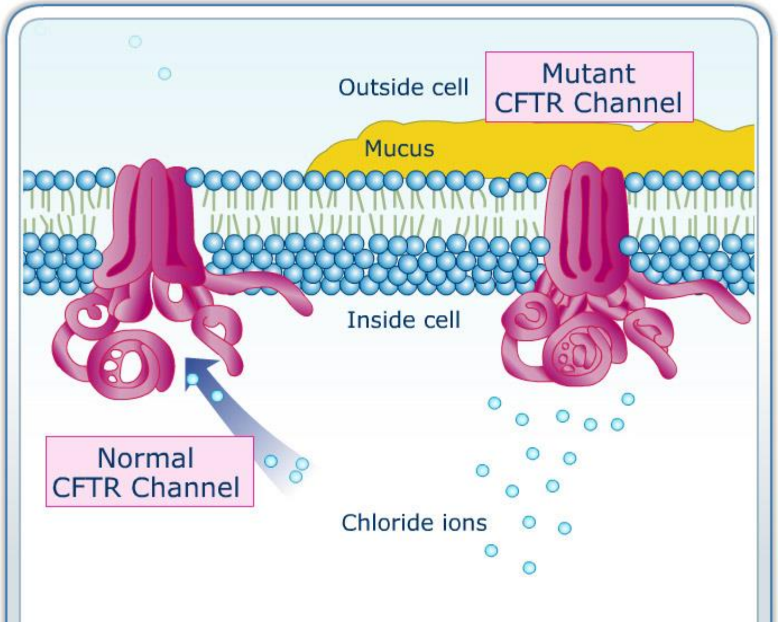
A protein is composed of two or more __amino__ __acids__ linked together through the process of __protein__ __synthesis__.
The bond formed is called a __peptide__ bond.

Proteins contain the elements __Carbon__, __Hydrogen__, __Oxygen__, and __Nitrogen__. Many proteins also contain sulfur (S).
Three examples of proteins are __enzymes__, __hormones__, and __antibodies__

receptors, hemoglobin, membrane carrier proteins

Cystic Fibrosis

The CFTR protein is a membrane transport protein that allows chloride ions to cross the cell membrane. Just one missing amino acid at the 508th position in the CFTR protein chain will cause the protein channel to form abnormally. This impairs the transport of chloride ions and the movement of water into and out of cells. As a result, cells that line the passageways of the lungs, pancreas, and other organs produce mucus that is abnormally thick and sticky. The abnormal mucus obstructs the airways and glands, leading to the characteristic signs and symptoms of the genetic disease, cystic fibrosis. People with cystic fibrosis have a shorter life span but can live on average to their 30s and 40s with treatment. There is no cure.



A normal-functioning CFTR channel moves chloride ions to the outside of the cell while a mutant CFTR channel does not, causing sticky mucus to build up on the outside of the cell.

1) Why might the 508th amino acid be missing from the CFTR protein chain in a person with cystic fibrosis?

2) Why do you think there is no cure?

Lesson 6

- Nutrients (Macromolecules)
  - Nucleic Acids
- Quiz Review

Review of Proteins

Amino acids have an __amino group__ at one end and a __carboxyl group__ (acid group) at the other end. A __variable group__ represented by the letter R is bonded to one of the carbons. There are (#) __20__ different amino acids found in living things. All amino acids are alike except they have a different R group.

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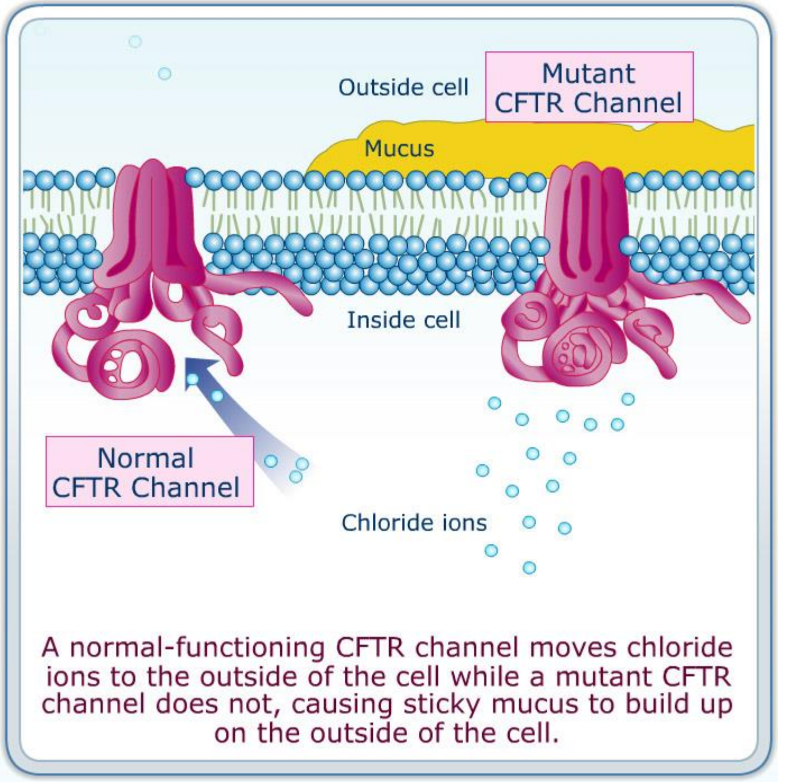
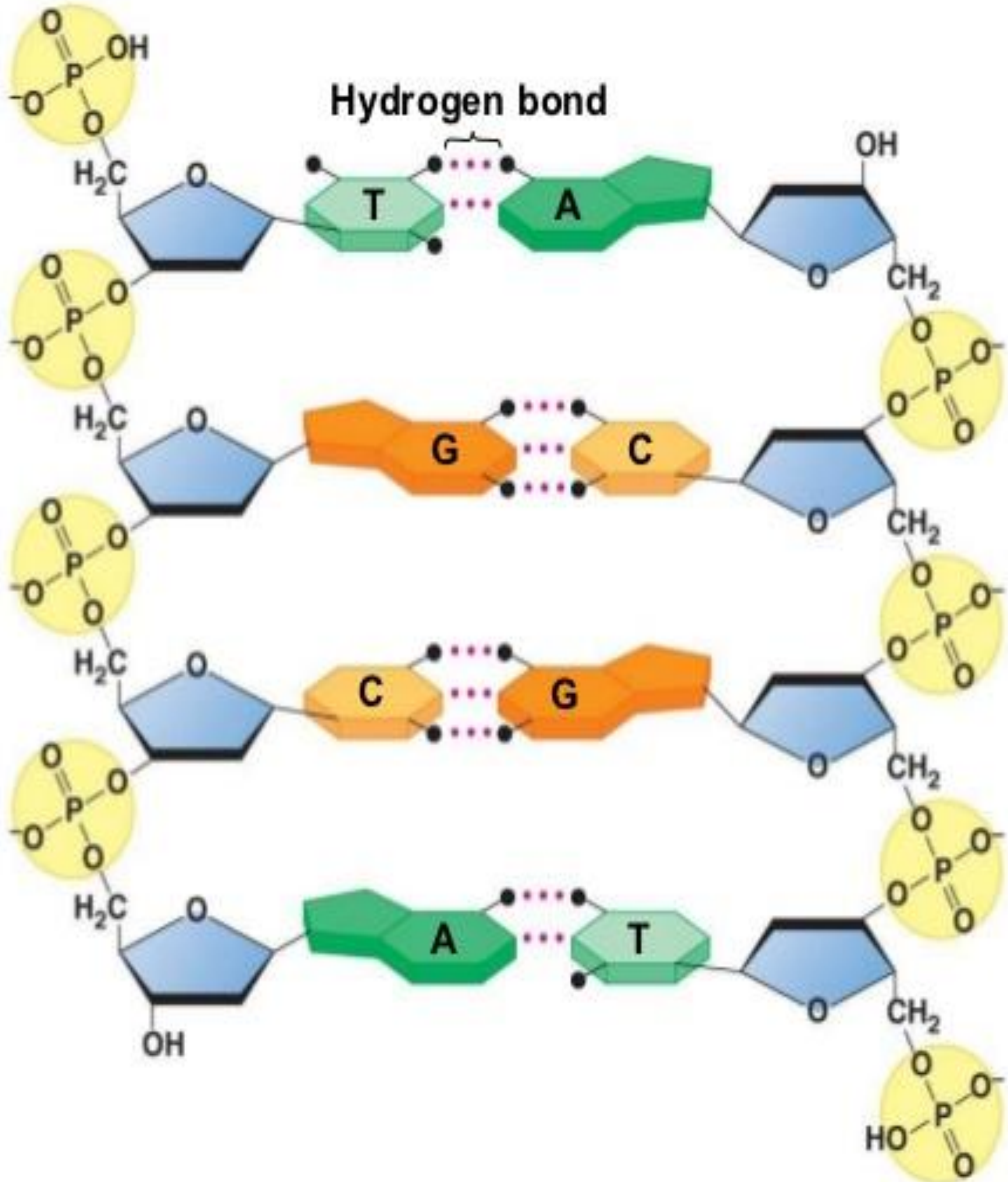
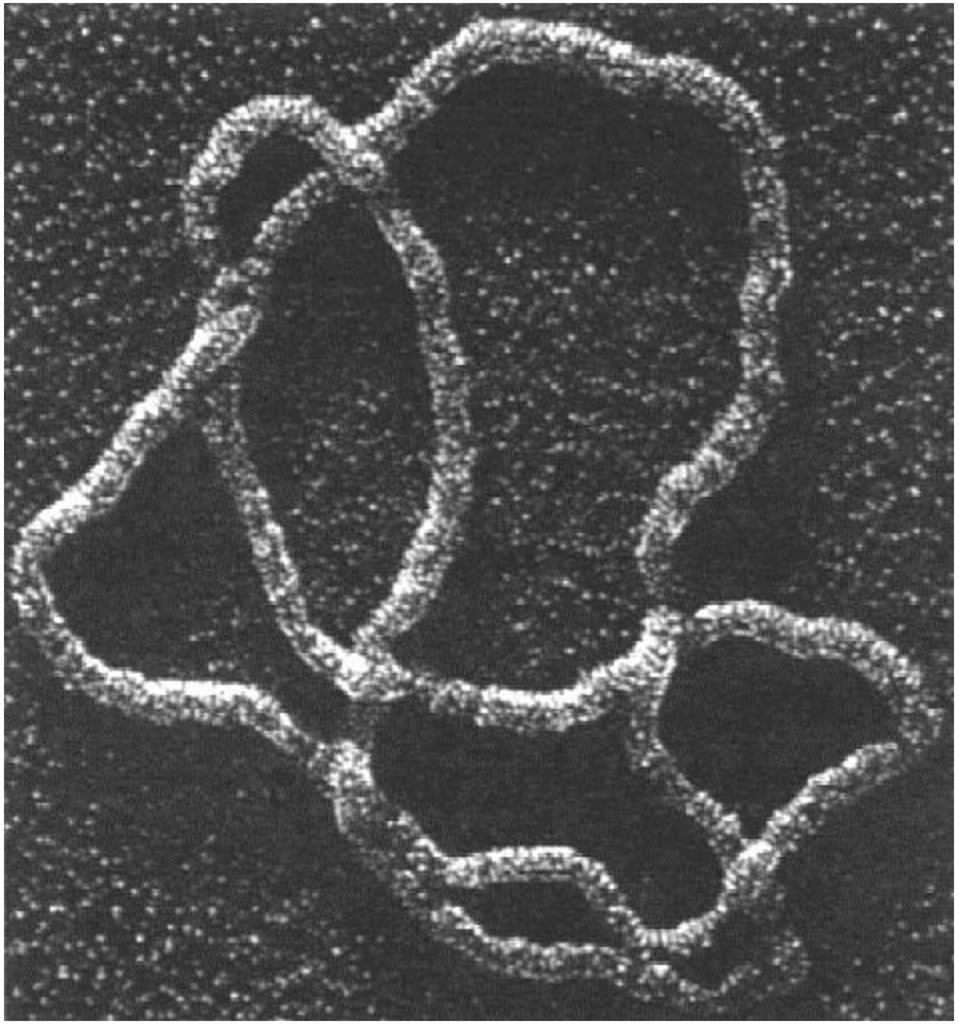


1) Why might the 508th amino acid be missing from the CFTR protein chain in a person with cystic fibrosis?

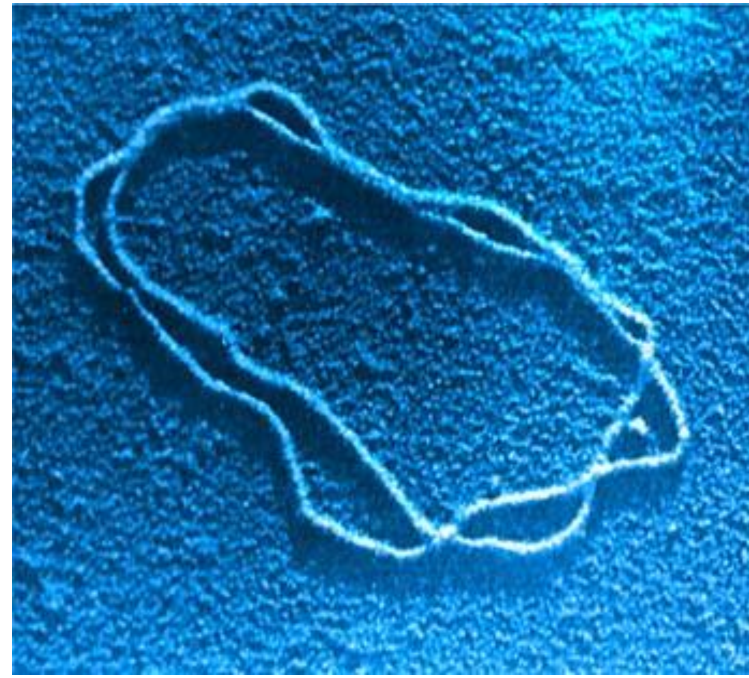
2) Why do you think there is no cure?

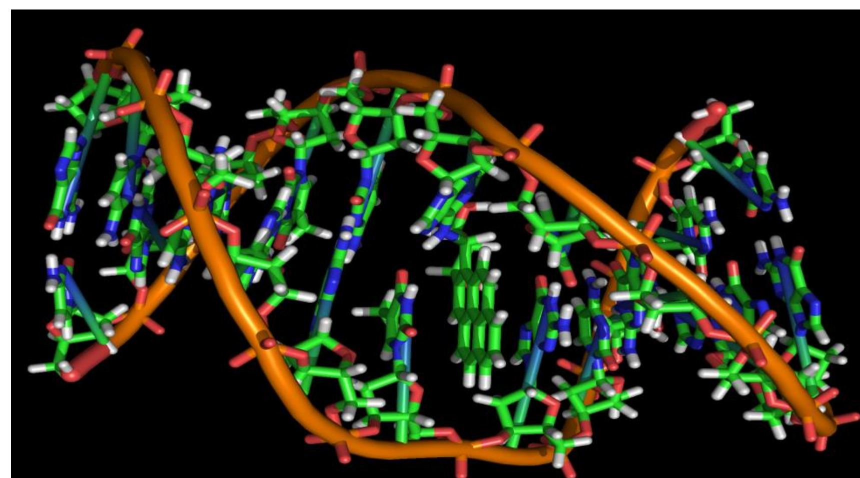
Based on what you have learned about biochemistry, make a few statements describing the molecule here…



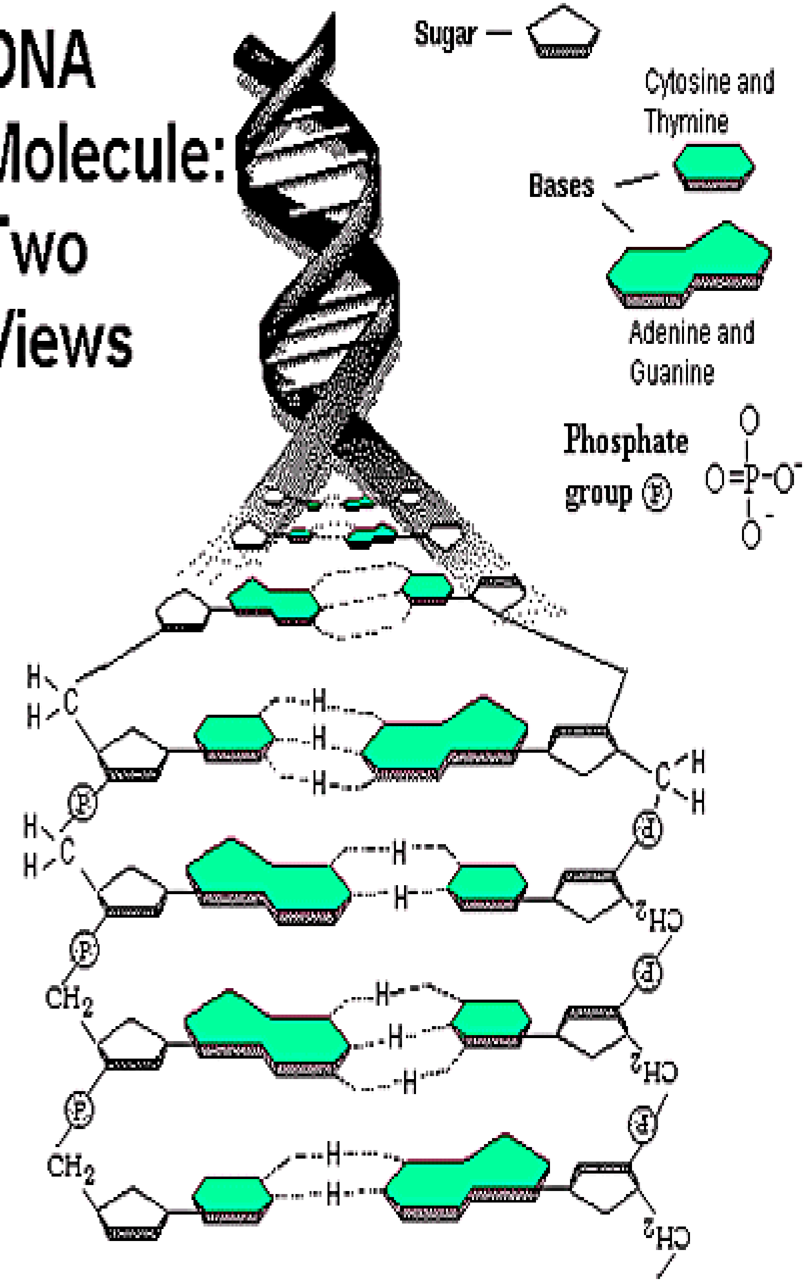


BRAINPOP!





DNA Molecule: Two Views

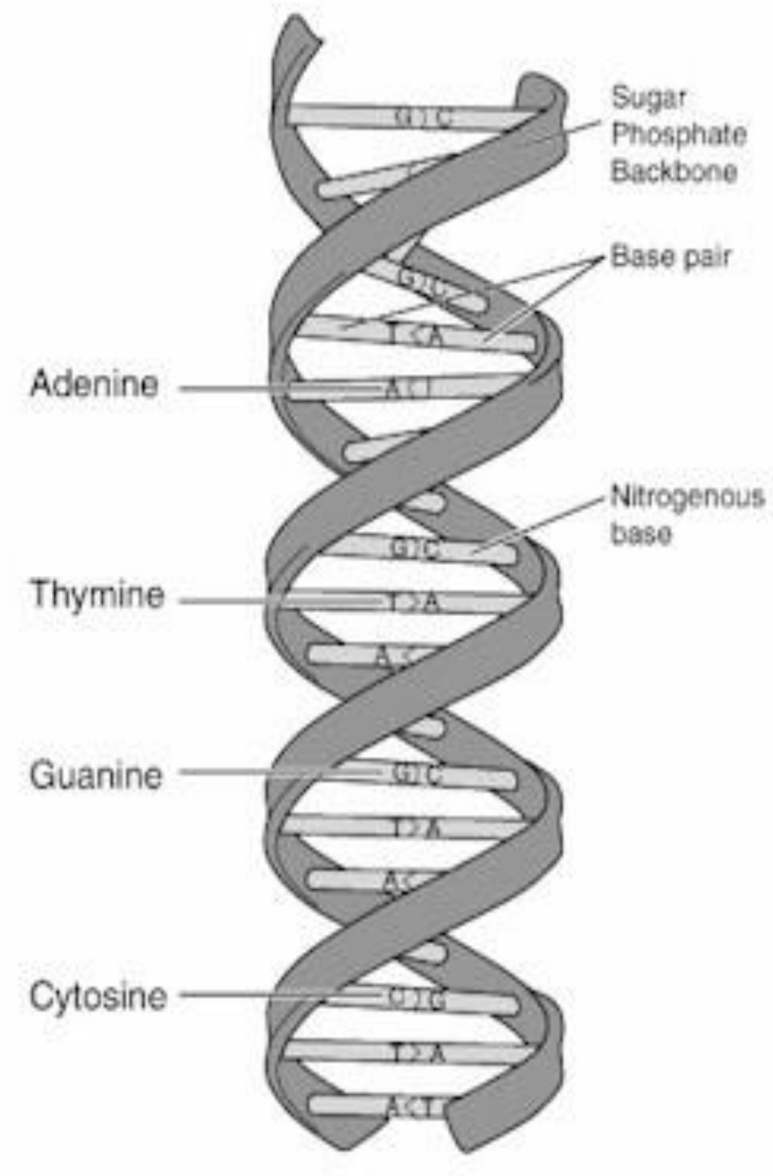


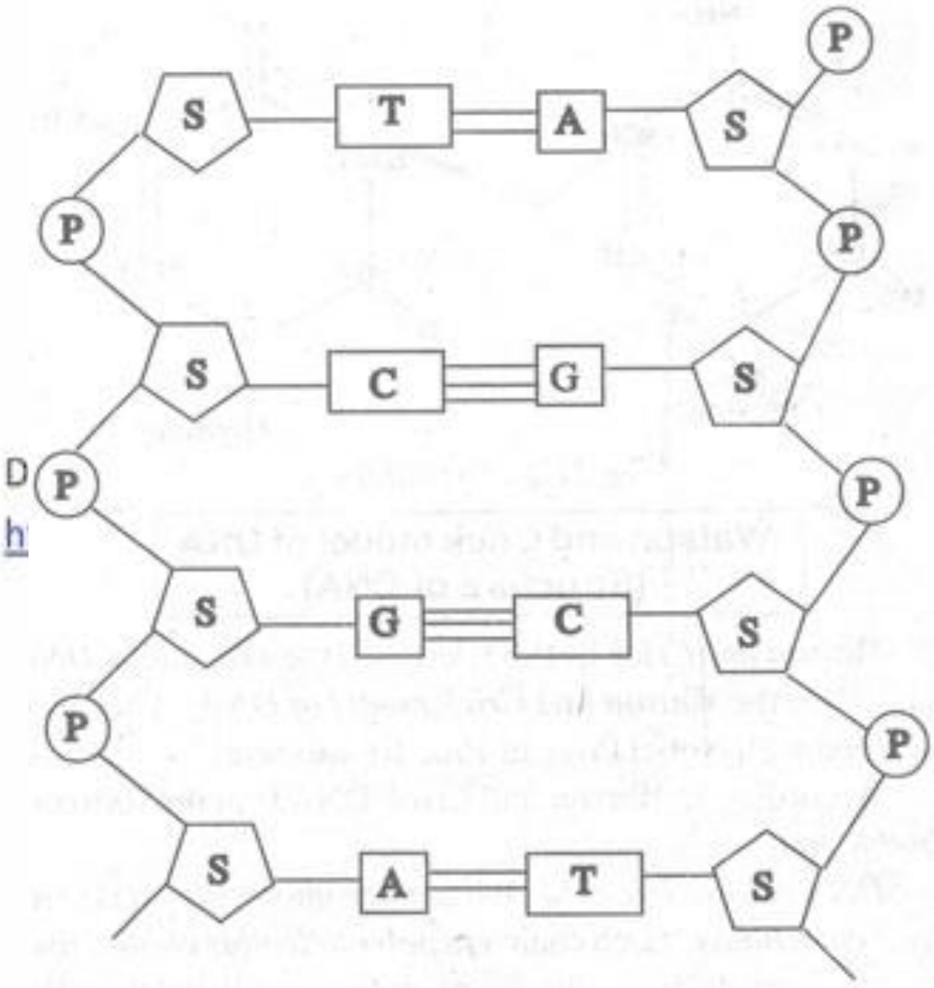
DNA Song!

(to the tune of “Row, row, row your boat”)

Oh we love DNA
made of nucleotides,
Phosphate, sugar, and a base
Bonded down the side…

Structure of DNA

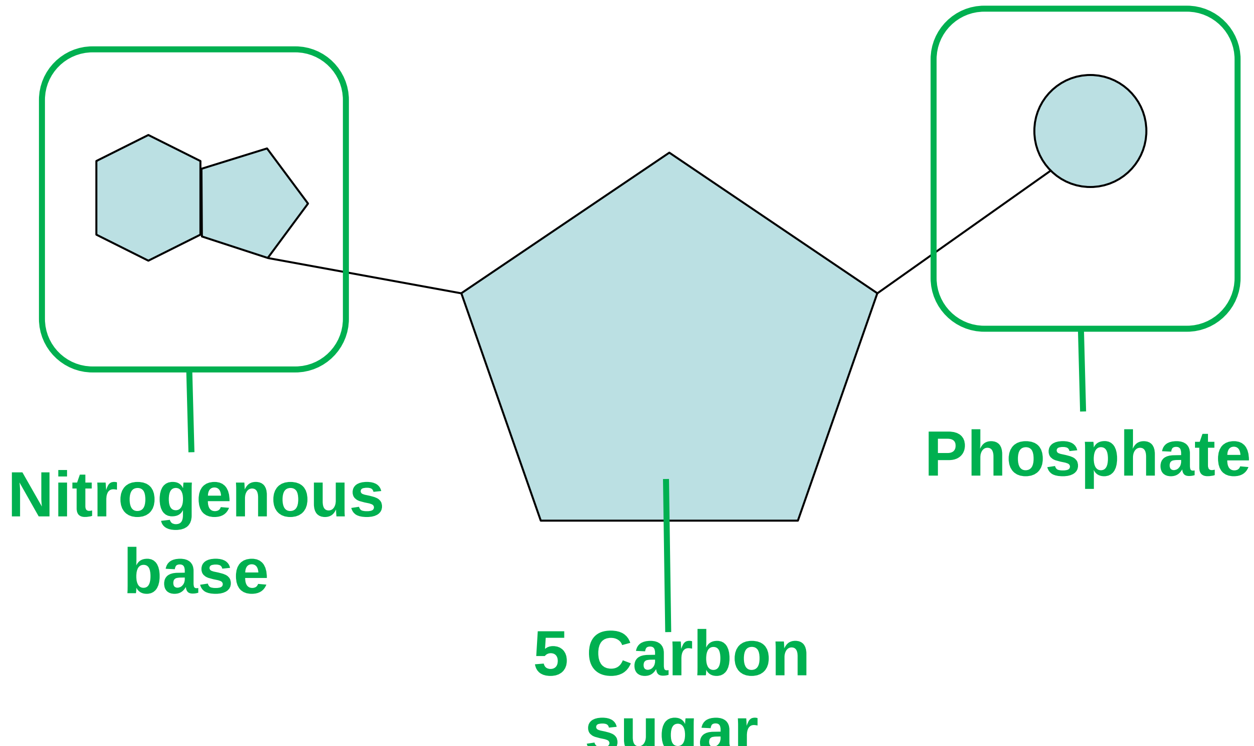




Characteristics	Nucleic Acids
Elements	Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus
Ratio	None
Building Blocks (Monomers → Polymers)	Nucleotides Each made up of a phosphate, sugar, and nitrogenous base
Functions	Store & transmit genetic information Provides instructions/code to ribosome for building proteins
Examples and Structure	DNA: deoxyribonucleic acid (sugar name = deoxyribose) RNA: ribonucleic acid (sugar name = ribose)

Nucleic Acids (con't)

Structural Diagram Nucleotide (monomer)	



Lesson 7

- Quiz
- Dehydration Synthesis and Hydrolysis

Review – Organic Compounds

Examine each group of terms. Cross out the one term that does not belong with the others write a name for the group. Use these choices:

proteins   lipids   nucleic acids   carbohydrates

1. **Nucleic acids**
   - DNA
   - RNA
   - genetic code
   - ribonucleic acid
   - ~~energy sources~~

2. **Proteins**
   - ~~galactose~~
   - amino acids
   - carboxyl group
   - NH_2
   - polypeptides

3. **Carbohydrates**
   - $C_6H_{12}O_6$
   - monosaccharides
   - ~~glycerol~~
   - maltose
   - glycogen

4. **Lipids**
   - energy reserves
   - fatty acids
   - ~~$C_{12}H_{22}O_{11}$~~
   - glycerol
   - waxes

Review – Organic Compounds

Determine if the statement is true. If it is not, rewrite the italicized part to make it true.

All organic compounds are compounds that contain *oxygen*. ____ **Carbon and Hydrogen**

Proteins are composed of fatty acids and glycerol. ____ **Lipids**

Carbohydrates usually contain hydrogen and oxygen in a ratio of *[illegible]*. ____ **2:1**

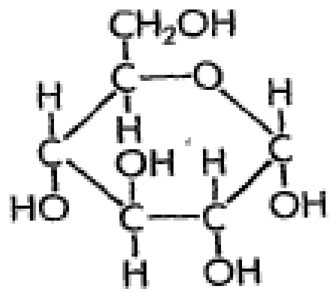
Maltose and sucrose are two examples of *monosaccharides*. ____ **Disaccharides**

Lipids include fats, oils, and waxes. ____ **TRUE**

Review – structural diagrams

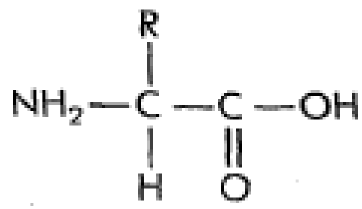
15. Identify the structural formula. Use these choices: *amino acid* *maltose* *glucose*

a.



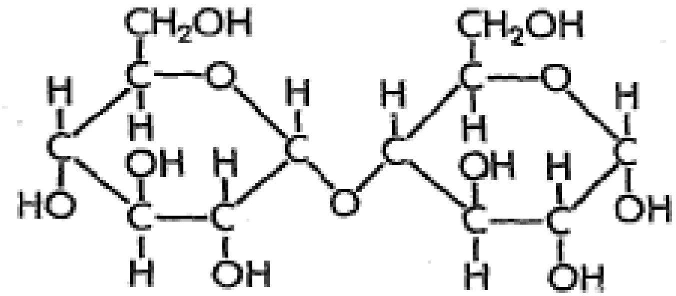
glucose

b.



amino acid

c.



maltose

amino acid **16.** When many are bonded together a protein is formed.

maltose **17.** It is a disaccharide with the formula $C_{12}H_{22}O_{11}$.

amino acid **19.** There are twenty different types of these.

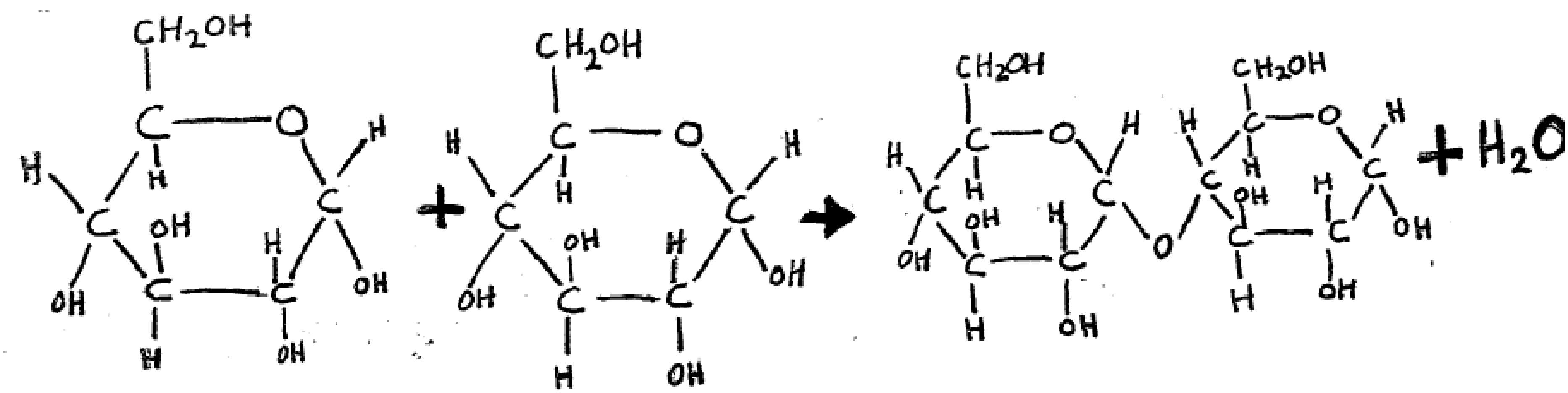
glucose **20.** This is a monosaccharide, or simple sugar.

Dehydration Synthesis

Definition

- putting small molecules together to build a larger molecule, by *removing* water

Glucose (monosaccharide) + **Glucose (monosaccharide)** → **Maltose (disaccharide)** + **water**

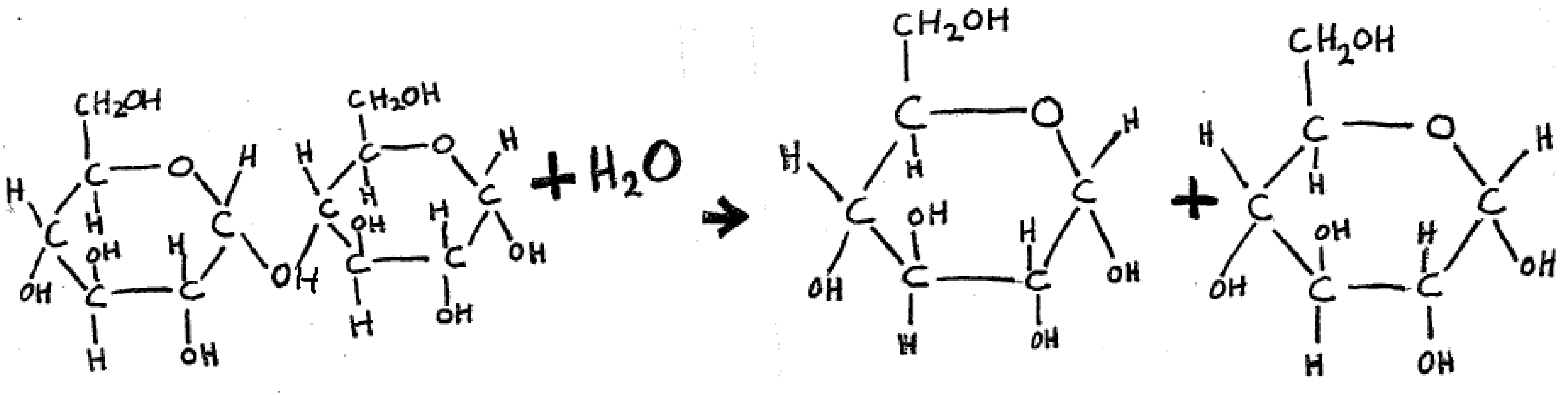


Hydrolysis

Definition

- Breaking apart large molecules into smaller building blocks by *adding* water

Maltose (disaccharide) + **water** → **Glucose (monosaccharide)** + **Glucose (monosaccharide)**

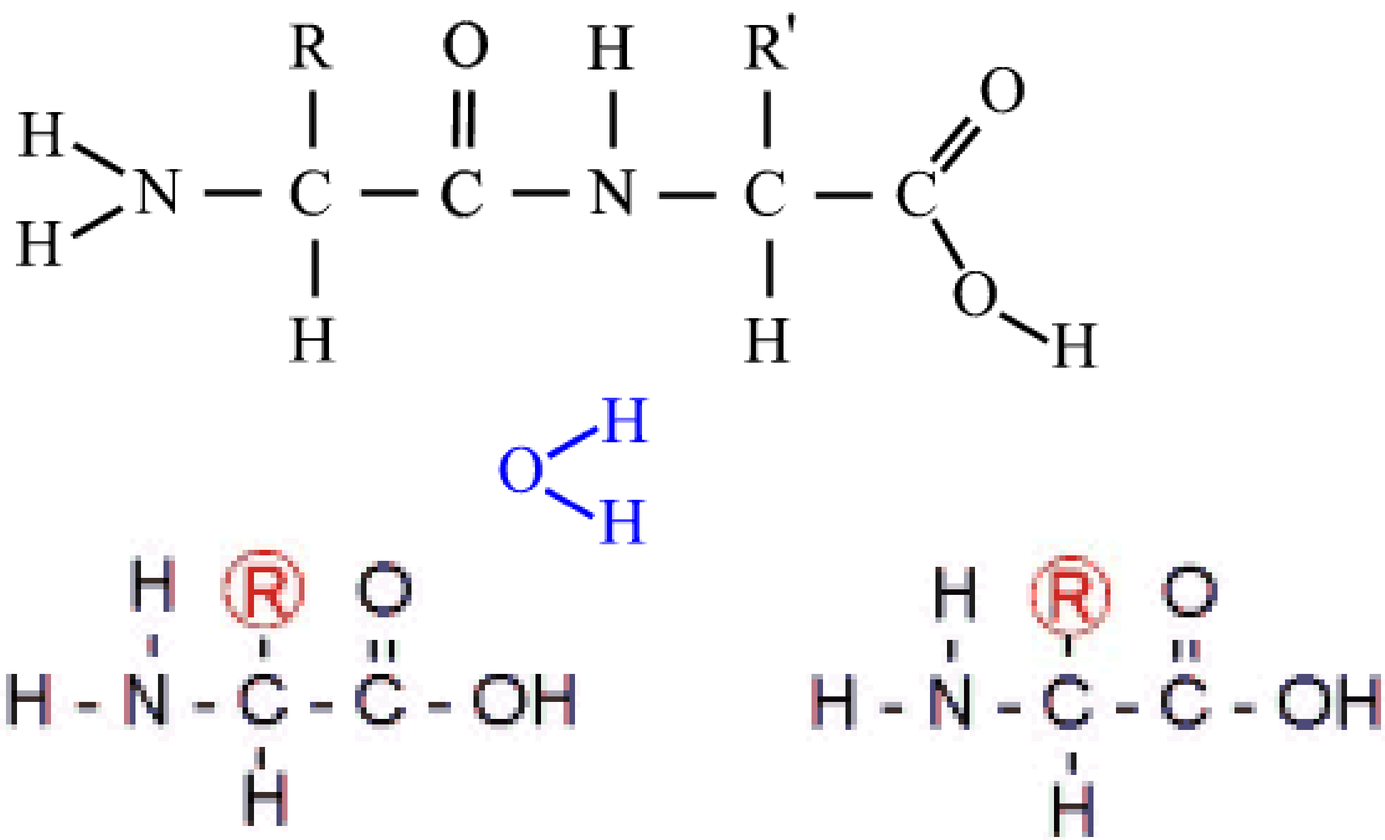


Also applies to other organic compounds:

3 fatty acids + **1 glycerol** → LIPID + water

amino acid + amino acid → **dipeptide** + water

Dehydration Synthesis or Hydrolysis?



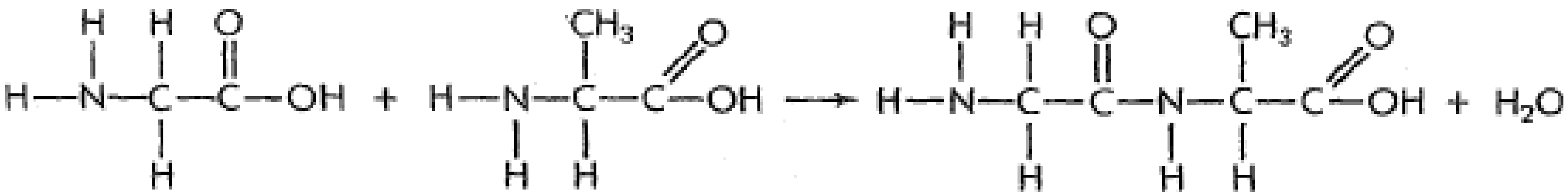
Hydrolysis!

Dehydration Synthesis!

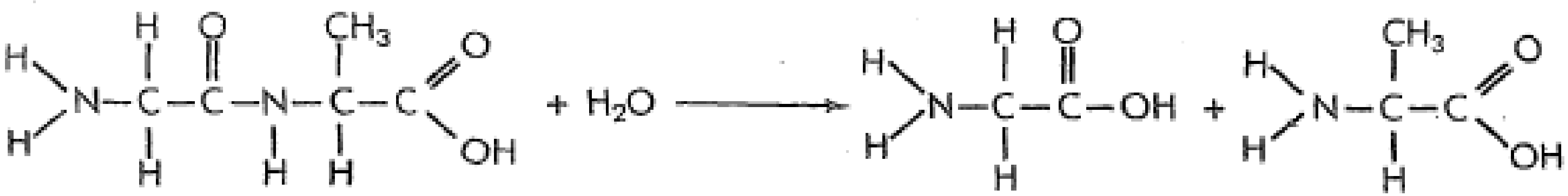
Dehydration Synthesis & Hydrolysis

Examine the chemical reactions below. Then identify them by placing the letter of the correct reaction, A or B, in front of each phrase below.

A **Dehydration Synthesis**



B **Hydrolysis**



__B__ 21. hydrolysis

__A__ 22. condensation

__B__ 23. large molecule is broken down into smaller molecules

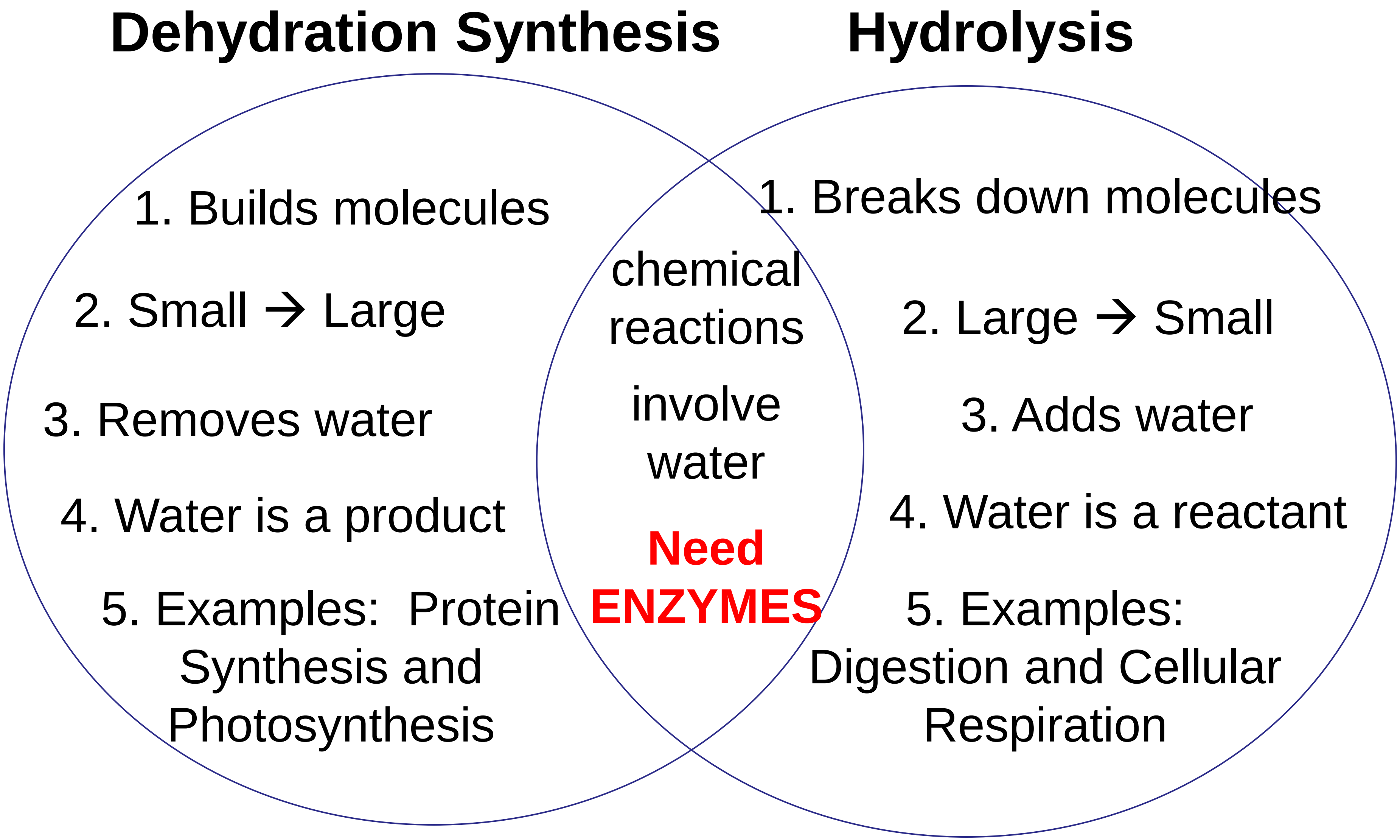
__B__ 24. involved in the digestion of food

__A__ 25. involves removal of water

__B__ 26. involves addition of water

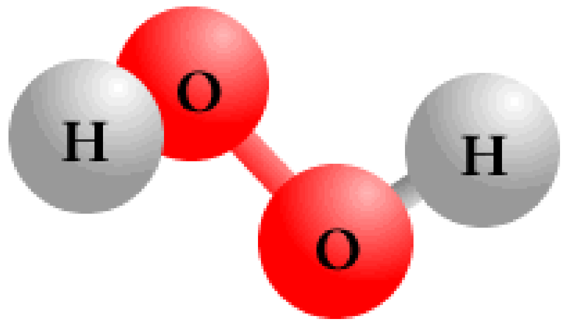
Lesson 8

- Enzymes
- Structure & function


Dehydration Synthesis
Hydrolysis
1. Builds molecules
2. Small → Large
3. Removes water
4. Water is a product
5. Examples: Protein Synthesis and Photosynthesis
chemical reactions
involve water
Need ENZYMES
1. Breaks down molecules
2. Large → Small
3. Adds water
4. Water is a reactant
5. Examples: Digestion and Cellular Respiration

Chemical Reaction with a Catalyst

H_2O_2 = Hydrogen Peroxide



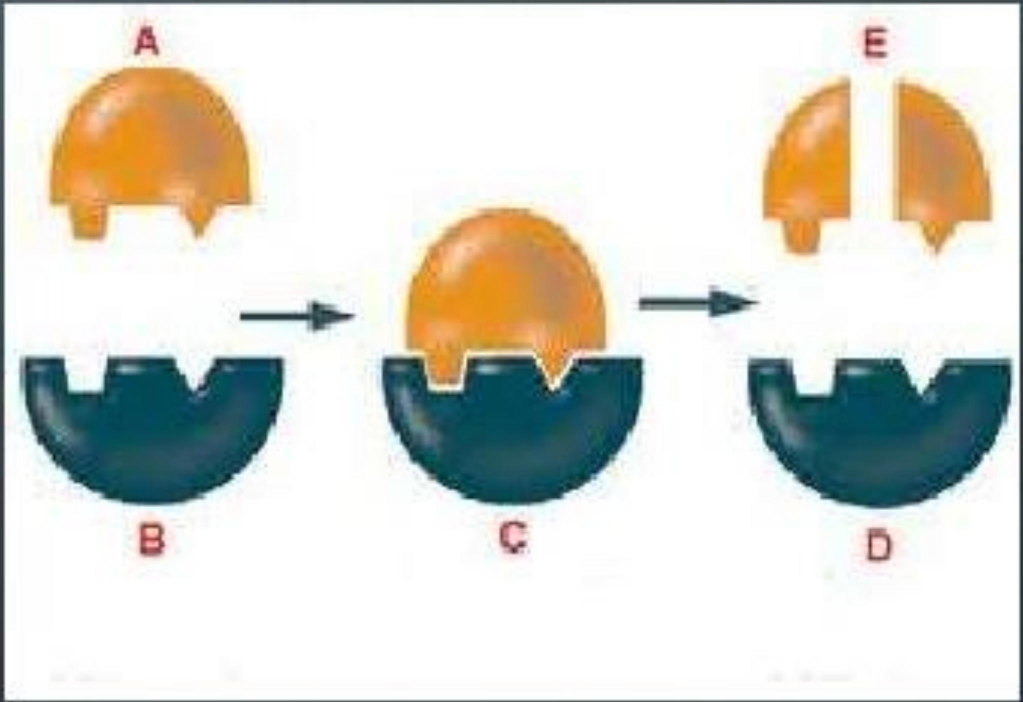
very slow reaction!

$$2H_2O_2 \xrightarrow{\text{light}} 2H_2O + O_2$$

very fast reaction!

$$2H_2O_2 \xrightarrow{\text{catalyst}} 2H_2O + O_2$$

- Which is the enzyme?
- Which is the substrate?
- What are the reactants?
- What are the products?



Enzymes - Function

- Enzymes control the rate of chemical reactions in living cells (speed them up!)
- AKA “biological catalysts” or “organic catalysts”
- Needed by ALL living things to perform chemical reactions
- Enzymes are specific to the molecule they act on (the substrate)
- Enzymes can be reused over and over

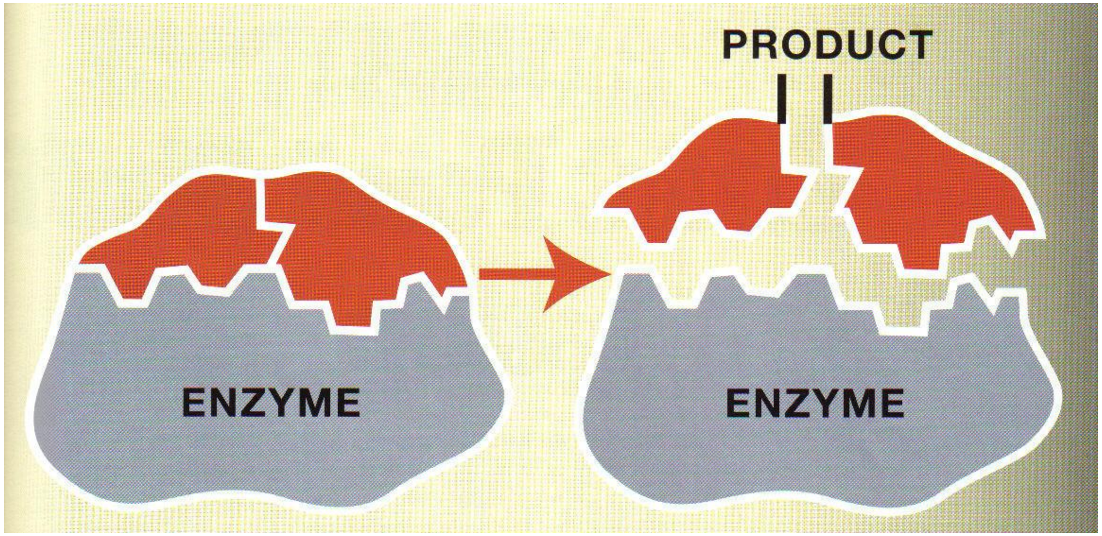
Enzymes - Structure

- Large complex PROTEIN molecules
- Names usually end in "ase"
  - Ex. Lipids are broken down by lipase
  - Ex. Proteins → protease
  - Ex. Lactose → lactase
  - Ex. Starch → amylase
- Enzymes have a specific shape that only fits with a specific substrate

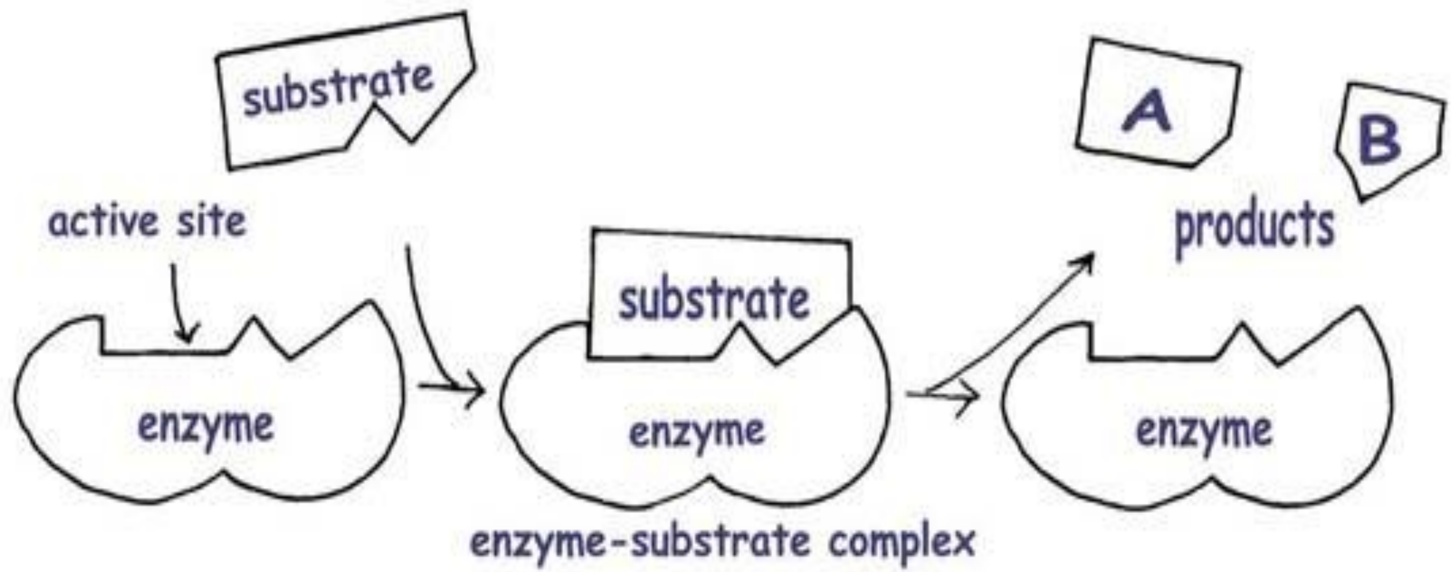
Enzymes - Structure

Active Site – small area of the enzyme that is involved in the reaction; shape makes the enzyme specific for fitting with its substrate

Enzyme Substrate Complex – formation when substrate is bound to the active site of an enzyme



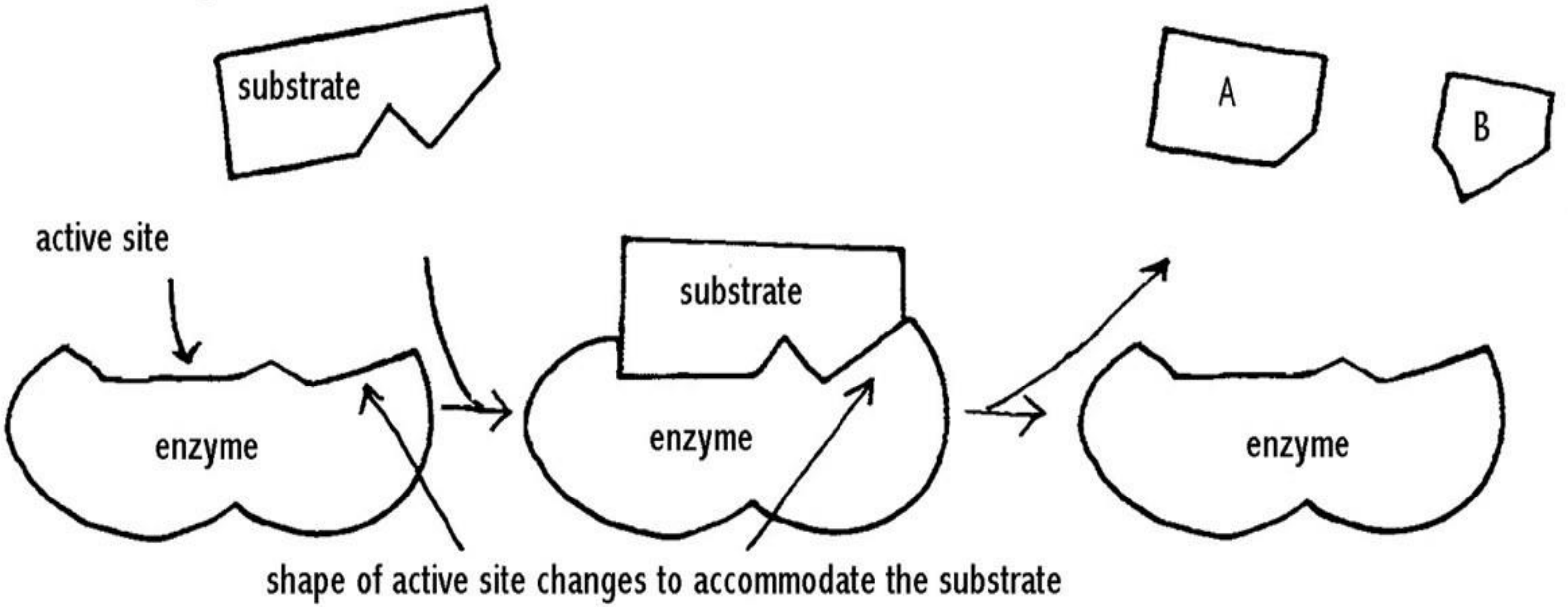
Models of Enzyme Action



Lock & Key Model

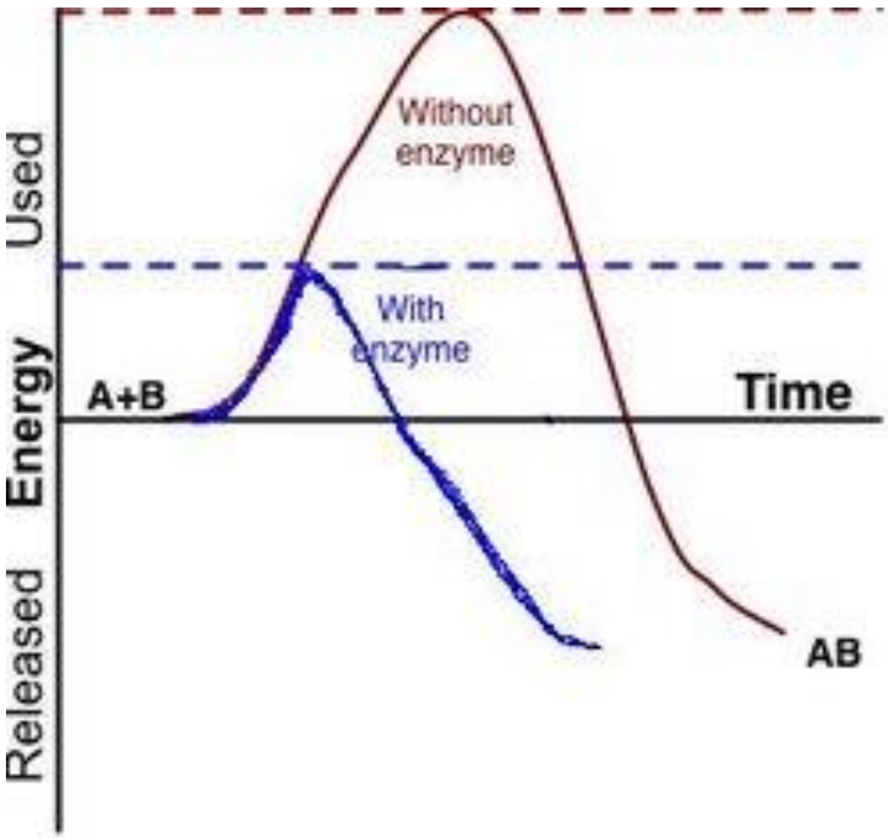
- Only one small part of the enzyme molecule (active site) can form a complex with the substrate
- Only a specific substrate can bond in that site (like only a specific key can open a lock)

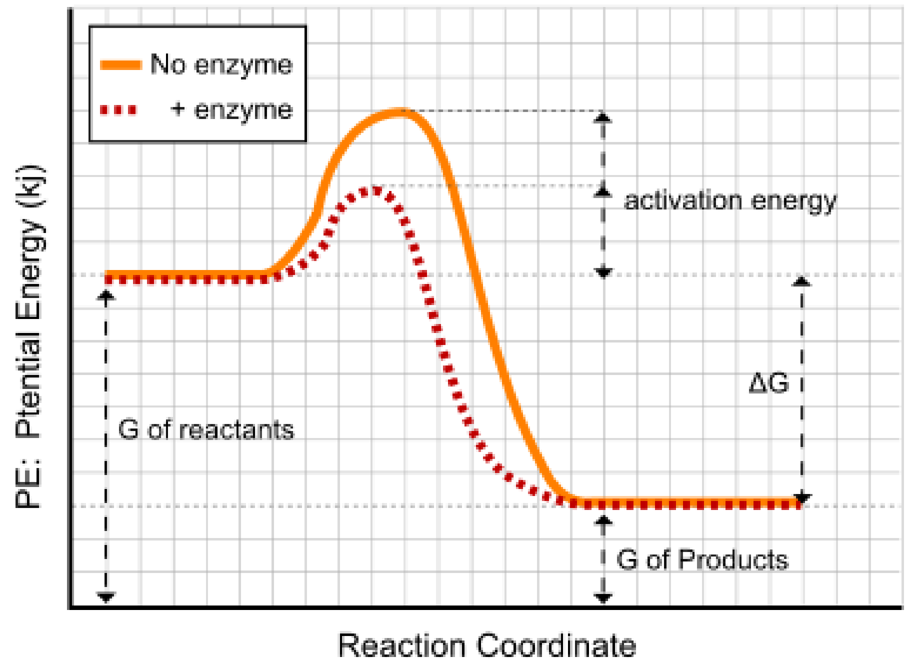
Models of Enzyme Action



Induced Fit Model

- Proposes that the active site slightly changes its shape to accommodate the substrate perfectly





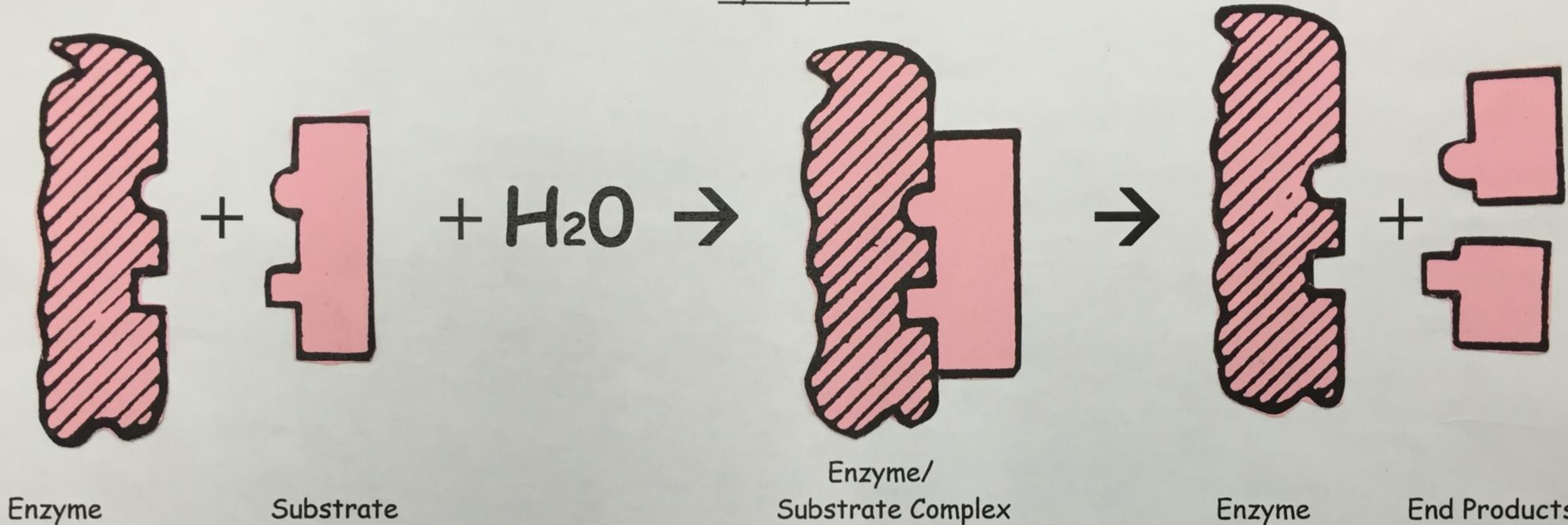
- Enzymes <u>lower the activation energy</u> needed to make reactions happen, therefore they happen faster

VIDEO

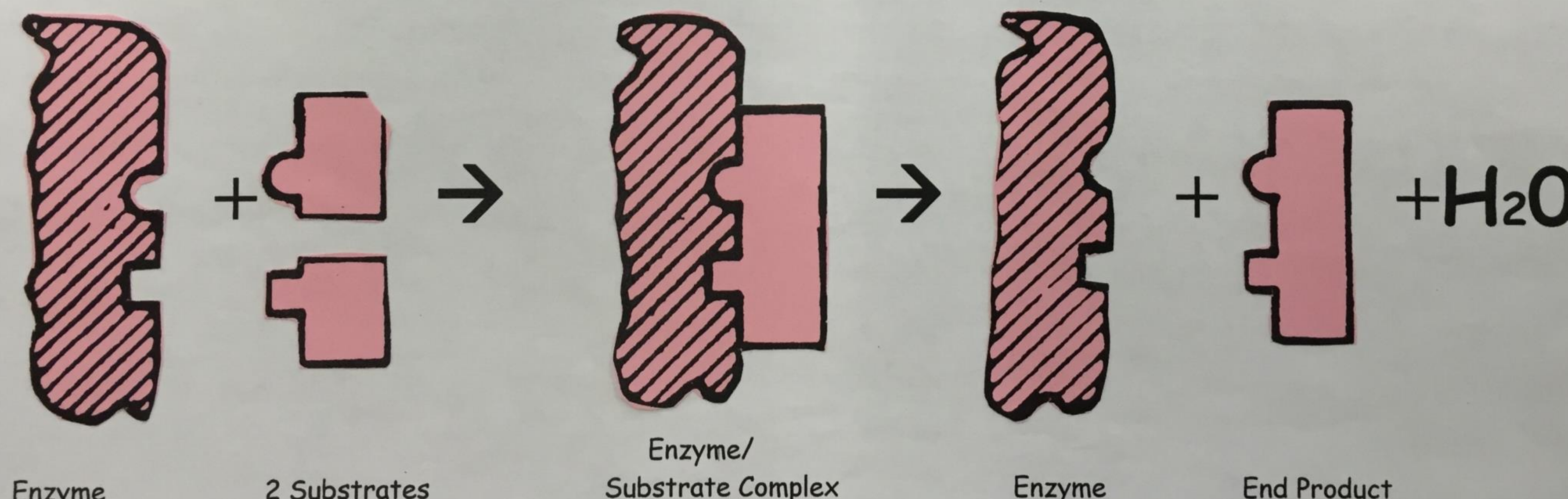
Lesson 9 & 10

- Environmental factors affecting rates of enzyme action
- Graphing rates of enzyme action

Hydrolysis



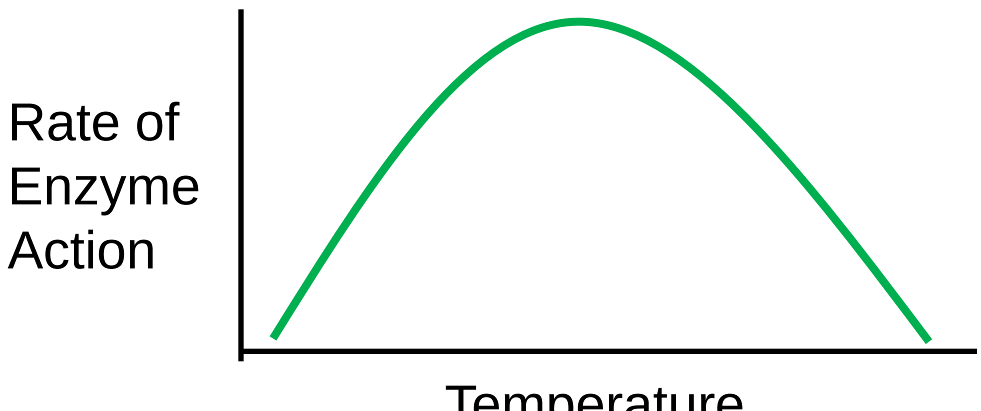
Dehydration Synthesis

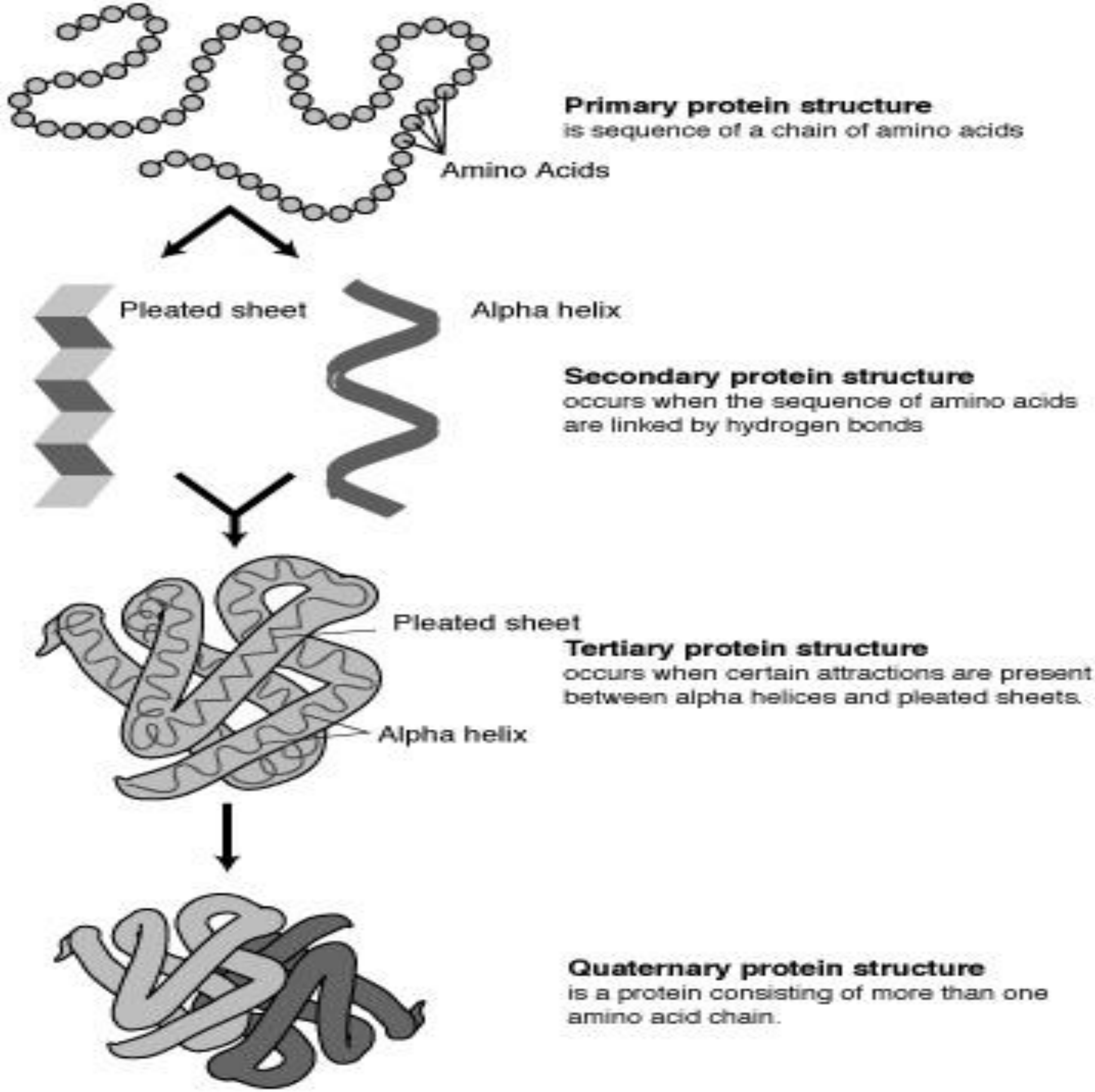


3 Factors Affecting Enzyme Rate of Reaction

1. Temperature

- Optimum temperature for most enzymes is
  37 degrees Celsius (body temperature)
- Below 37 degrees → function slowly
- Above 37 degrees → become misshaped and get destroyed or ***denatured*** (no longer work)

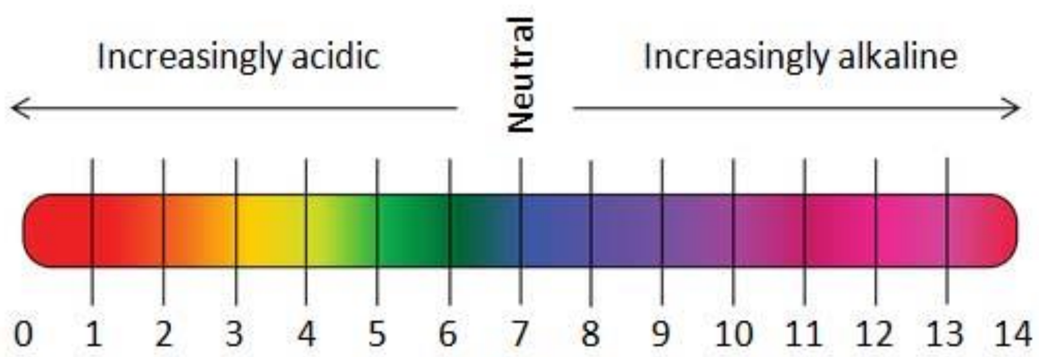


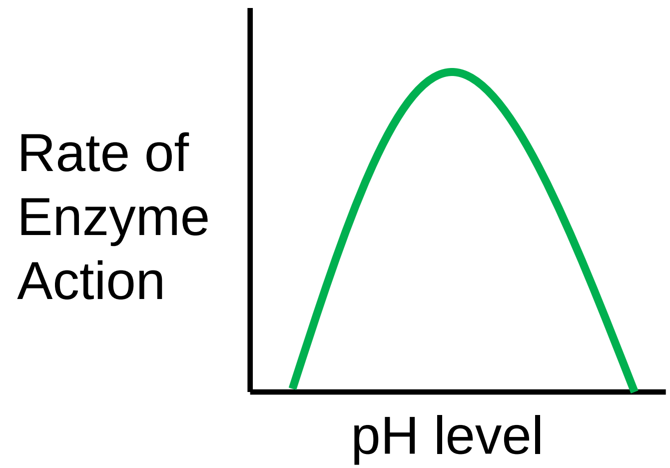


Primary protein structure
is sequence of a chain of amino acids
Amino Acids
Pleated sheet
Alpha helix
Secondary protein structure
occurs when the sequence of amino acids
are linked by hydrogen bonds
Pleated sheet
Tertiary protein structure
occurs when certain attractions are present
between alpha helices and pleated sheets.
Alpha helix
Quaternary protein structure
is a protein consisting of more than one
amino acid chain.

2. pH level

- Scale ranging from 0-14 that measures how acidic or alkaline a substance is.
- Enzymes function best at a specific pH level
- Most work best at neutral pH of 7 however, some vary: Ex. Pepsin in stomach = pH 3-4 (acidic)





Note: Each value on the pH scale has 10x more/less of the amount of acidic/alkaline ions as the next number on the scale. Ex. pH of 2 is 10x stronger of an acid than pH of 3

<u>3. Relative Amounts of Enzyme and Substrate</u>

- More <u>enzyme</u> present increases enzyme activity to a certain point and then levels off
- More <u>substrate</u> present increases enzyme activity to a certain point and then levels off