Honors Biology

Class Notes

North Salem High School

MISSION: *Engage students to continuously learn, question, define and solve problems through critical and creative thinking.*

Biochemistry

(pp.33-75)

If you have any problems – please sign up for extra help after school.

Mr. Collea
Room W-19

OBJECTIVES:

Upon completion of this unit the student will:

___ **1.** define ***biochemistry***
___ **2.** describe the structure of an atom and the arrangement of electrons around the nucleus.
___ **3.** explain the formation of ***covalent*** and ***ionic bonds***.
___ **4.** define the following terms and give examples of each:
molecule, ***diatomic molecule***, ***ion***, ***chemical formula***, and ***structural formula***.
___ **5.** list the 4 most common elements found in living things
___ **6.** explain the difference between ***inorganic*** and ***organic*** compounds.
___ **7.** recognize that ***water*** is a ***polar molecule*** and is the most important inorganic compound for life.
___ **8.** state 3 properties of water that make it the most important inorganic compound for living things.
___ **9.** state the function(s) of ***carbohydrates***.
___ **10.** recognize that ***glucose*** is the building block of all carbohydrates.
___ **11.** recognize the chemical formula of carbohydrates and chemical structure of ***glucose***.
___ **12.** list several examples of carbohydrates.
___ **13.** recognize that carbohydrate names tend to end in -ose.
___ **14.** Compare nd contrast the ***dehydration synthesis*** and ***hydrolysis*** of carbohydrates, lipids and proteins.
___ **15.** explain the difference between a ***mono*saccharide**, ***di*ssacharide**, and ***poly*saccharide**
___ **16.** list three examples of ***polysaccharides*** and state their functions.
___ **17.** state the function(s) of ***lipids*** in the body.
___ **18.** recognize that all lipids are made up of ***3 fatty acid*** and ***1 glycerol*** molecule.
___ **19.** list some examples of ***lipids*** and recognize "good" fat from "bad" fat.
___ **20.** identify the two types of ***nucleic acids***.
___ **21.** recognize that ***proteins*** are composed of building blocks called ***amino acids***.
___ **22.** recognize the chemical formula, chemical structure and functional groups found in amino acids.
___ **23.** state that name of the chemical bond that links one amino acid molecule to another forming a ***dipeptide***.
___ **24.** explain what is meant by a ***dipeptide*** and a ***polypeptide***.
___ **25.** list five examples of polypeptides.
___ **26.** explain in a sentence or two why there are so many possible kinds of proteins.
___ **27.** recognize that protein structure determines its function.
___ **28.** describe the structure and explain the functions of ***enzymes*** in living things.
___ **29.** describe the ***lock and key model*** and the ***induced-fit model*** of enzyme action.
___ **30.** explain the effects temperature and pH have on enzyme action.
___ **31.** explain the meaning of the ***pH scale*** and identify pH values as either an acid or a base..

KEY WORDS:

- biochemistry
- cohesion
- glucose
- disaccharide
- proteins
- amino group
- polarity
- catalyst
- pH
- organic
- adhesion
- cellulose
- polysaccharide
- amino acids
- carboxyl group
- enzyme
- ionic bond
- hydrolysis
- inorganic
- carbohydrates
- Benedict's Solution
- starch
- Lugol's Solution
- dipeptide
- substrate
- covalent bond
- dehydration synthesis
- water
- photosynthesis
- monosaccharide
- lipids
- peptide bond
- polypeptide
- active site
- denaturation
- lock and key model

BIOCHEMISTRY is defined as the study of the atoms, molecules and chemical reactions that make up LIFE.

I. BIOCHEMISTRY TODAY

- The molecular basis of many biological processes is now understood.

EXAMPLES:

(1) How the nucleus act as the control center of the cell?

- **DNA ⟶ RNA ⟶ Proteins**

(2) How the 3-D structure of proteins dictates their function.

(3) How the double-helix structure of DNA enables it to copy itself.

- Advances in biology + chemistry will allow the scientists of tomorrow to find the answers to some of the more challenging questions in biology and medicine today.

EXAMPLES:

(1) How do organisms grow and develop from a single cell (zygote)?

- cell -----> tissue -----> organ -----> organ system -----> organism

(2) What is the cure for diseases such as cancer and aids?

(3) The Aging Process; How and why we get old?

(4) Mapping the human genom. (*been there...done that in 2002*)

(5) Mapping the human brain.

II. ELEMENTS OF LIFE

- The cell is a complex "chemical factory" made up of the same **atoms** and **molecules** that show up over and over again in **ALL** living things or **organisms**.

  (These atoms and molecules are also found in the non-living environment)

- Of all of the atoms/elements found on earth, there are four main ones that are present in the greatest percentage (amounts) in living things. They are:

Element	*Symbol*	*# of Bonds*
Carbon	C	
Hydrogen	H	
Oxygen	O	
Nitrogen	N	

C.H.O.N

- There are other elements that are also found in living things but in much smaller quantities. These are:

ELEMENT	SYMBOL
Phosphorus	P
Potassium	K
Iodine	I
Sulfur	S
Calcium	Ca
Iron	Fe
Magnesium	Mg

All the elements important to living things together spell:

C. HOPKINS CaFe Mg (Mighty good)

III. COMPOUNDS OF LIFE

- **ALL** organisms are made up of **inorganic** and **organic** compounds.

A. INORGANIC COMPOUNDS

- **compounds that do NOT contain carbon AND hydrogen**

EXAMPLES:

NAME	FORMULA
water	H_2O
carbon dioxide	CO_2

- The **MOST** important inorganic compound for living things is **water**.

(1) WATER *(Textbook p. 58-59)*

- At least **70%** of living things are made up of water.
- ***Water has many unique properties ESSENTIAL to living things***

a) Water is **polar** molecule. [*Figure 4-2*]

- Water is a compound made up of 1 oxygen atom and 2 hydrogen atoms. Because oxygen is bigger, it holds the negatively charged electron it shares with hydrogen closer to itself thus giving oxygen a partial negative charge. The hydrogen atoms thus become less negative OR partially positive.

b) **Cohesion** - The ability of water molecules to "stick" to other water molecules.

c) **Adhesion** - The ability of water molecules to "stick" to different molecules.

d) Water reached it maximum **density** at **4** °C.

For this reason ICE floats!

(THINK about it?)

B. *ORGANIC COMPOUNDS*

- compounds that DO contain carbon AND hydrogen

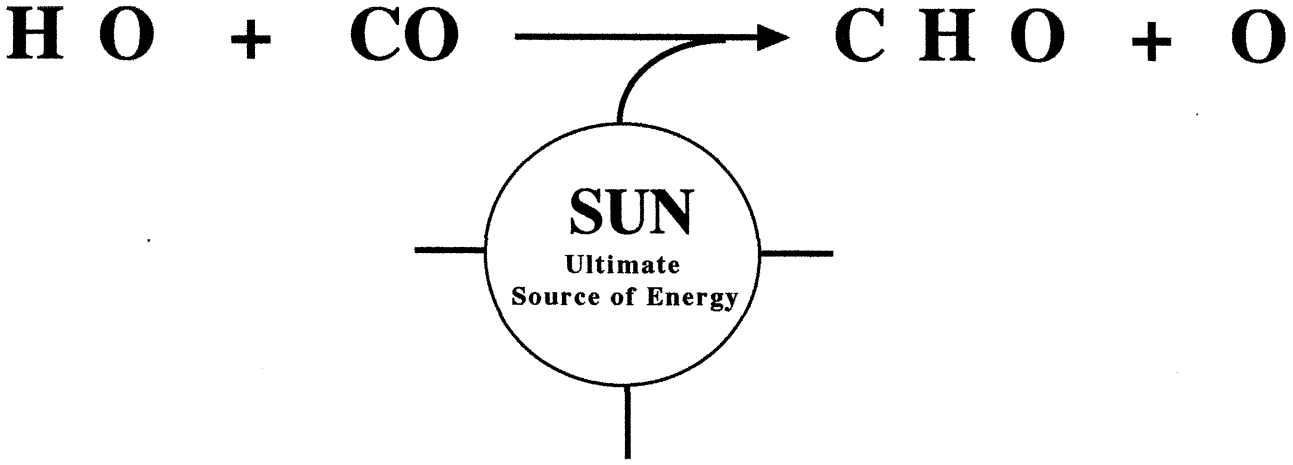
- The MOST important organic compounds for living things are:

ORGANIC COMPOUNDS	COMPOSITION	FUNCTION(s)
Carbohydrates	C - H - O	IMMEDIATE energy
Lipids / Fats	C - H - O	STORED energy
Proteins	C - H - O - N	Growth and Repair
Nucleic Acids	C - H - O - N - P	Genetic material

(1) *CARBOHYDRATES* *(Textbook pp.60-62)*

- made up of the elements carbon, hydrogen and oxygen
- hydrogen and oxygen are in a **2 : 1** ratio
  (*this means that there is twice as many hydrogen atoms as oxygen atoms*)
- chemical name usually ends in - OSE
- ALL carbohydrates are made up of the simple sugar glucose.
- Glucose is made by plants via the process of photosynthesis.

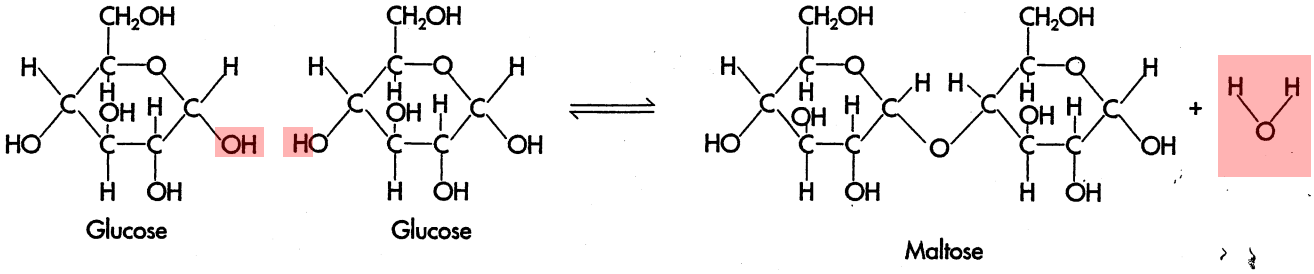
FORMULA for PHOTOSYNTHESIS:



• The **building** and _____ of carbohydrates.
(dehydration synthesis) *(hydrolysis)*

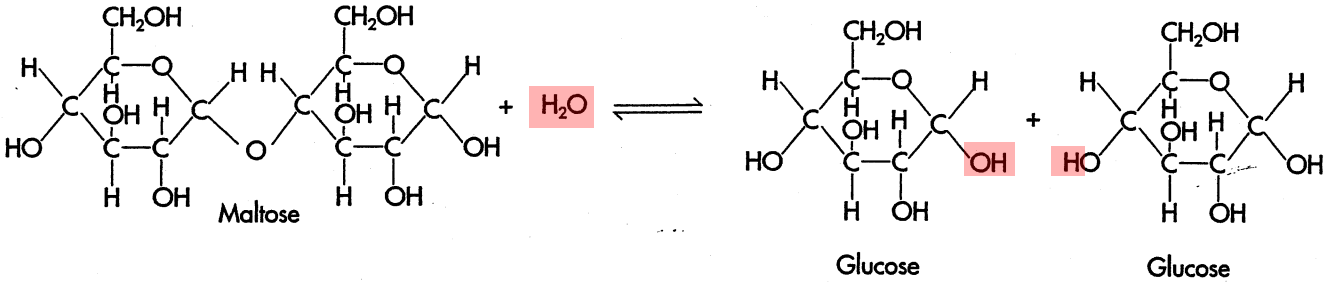
DEHYDRATION SYNTHESIS *[Figure 4-7]*

(water removal) *(to build, put together)*



HYDROLYSYS *[Figure 4-8]*

(water) *(to split)*



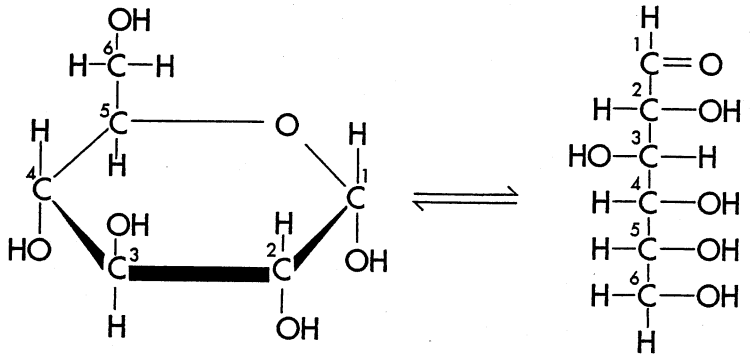
Some Common Carbohydrates:

NAME	FORMULA	TYPE	FUNCTIONS
Glucose			
Maltose			**-----> Glucose**
Lactose		**DIsaccharide**	**-----> Glucose**
Sucrose		**DIsaccharide**	**-----> Glucose**
Cellulose			
Glycogen		**POLYsaccharide**	
Starch		**POLYsaccharide**	

GLUCOSE:

(A closer look)

- produced by **GREEN** plants by the process of **photosynthesis**.
- converted into **ATP** by the process of **cellular respiration**.
- detected in a laboratory by the use of **Benedict's Solution**.
- regulated in the body by the hormones **insulin** and **glucagon** which are both produced by the **pancreas**.
- excess glucose is stored in the **liver** as **glycogen** (stored animal starch).
- **CHEMICAL FORMULA** = **$C_6H_{12}O_6$**
- **CHEMICAL STRUCTURE:**

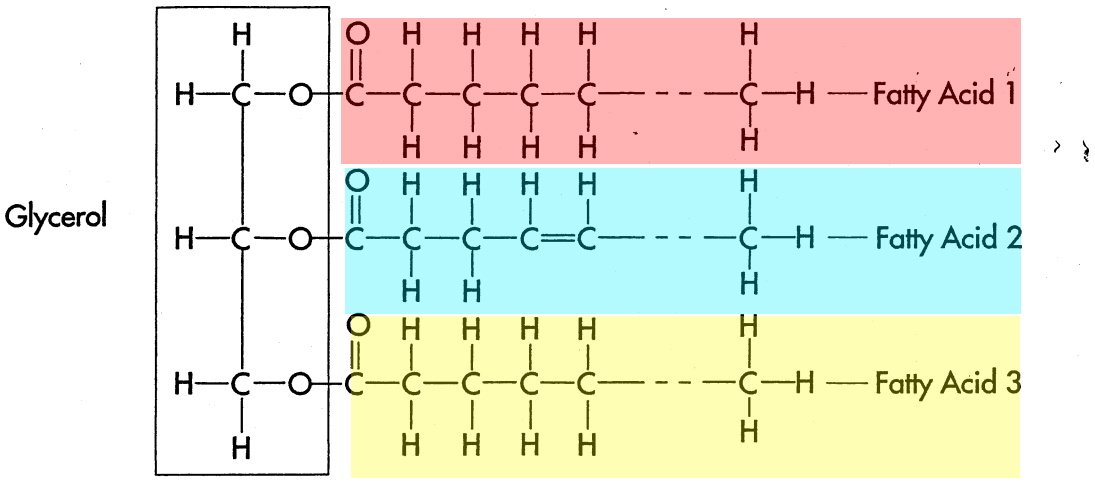


Ring form of glucose

Straight-chain form of glucose

(2) *LIPIDS and FATS* *(Textbook pp.62-63)*

- made up of the elements carbon, hydrogen and oxygen.
- hydrogen and oxygen are **NOT** in a **2 : 1** ratio (lipids have less oxygen)
- Lipids are made up of **ONE** glycerol molecule chemically combined to **THREE** fatty acid molecules.



- A *fancy-schmancy* name for lipids is _____.
- Lipids 3 main functions include:
  - (1) stored energy - energy to be used at a later date
  - (2) cushioning
  - (3) insulation

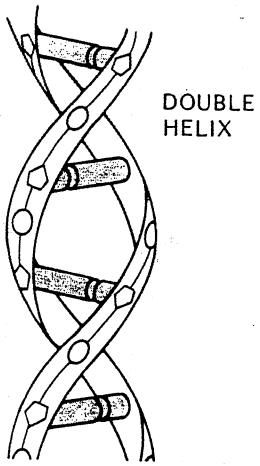
"Good" Fat	"Bad" Fat
Fat derived from plants.	Fat derived from animals.
Liquid at room temperature.	"Solid" at room temperature.
Generally "good" for your health.	Generally "bad" for your health.

(3) *NUCLEIC ACIDS* *(Textbook pp.64-65)*

- made up of the elements carbon, hydrogen, oxygen, nitrogen and phosphorus.
- nucleic acids are present in **ALL** cells.
- the **TWO** types of nucleic acids are:

a) DNA = **D**eoxyribo**N**ucleic **A**cid [Figure 4-12]

- DNA is a 2 - sided or double-stranded molecule that has a "twisted ladder" appearance called the double helix.



- DNA is found in the chromosomes of the nucleus.
- DNA contains the genetic code of instructions that direct a cell's activity through the synthesis of proteins.

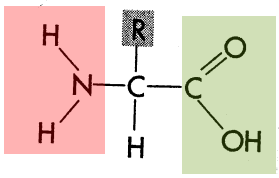
b) RNA = **R**ibo**N**ucleic **A**cid

- a 1 - sided or single-stranded molecule that helps in the production of proteins or protein synthesis.
- found in nucleolus and the ribosome

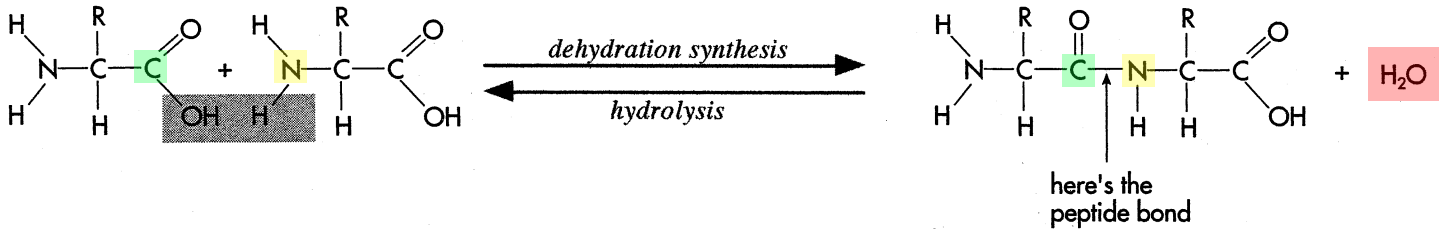
DNA controls all cell activites by controlling the production of...

(4) *PROTEINS* *(Textbook pp.66-67)*

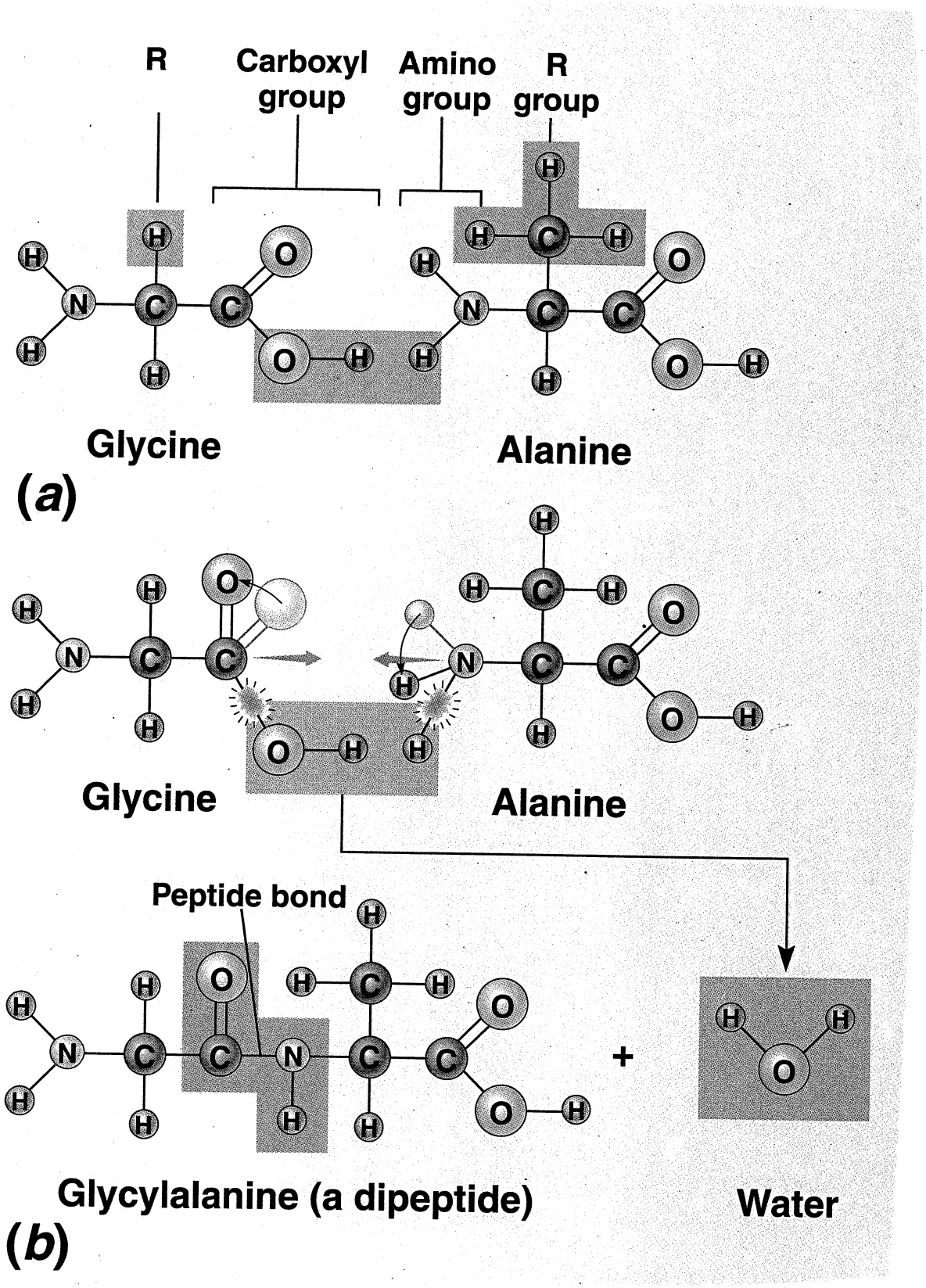
- made up of the elements C, H, O, and N, (S).
- **ALL** proteins are made up of building blocks called amino acids.
- Every amino acid molecule has 2 important parts.
- These parts or *groups* of atoms that perform various *functions* are called functional groups.
- The basic structure and *functional groups* found in every amino acid molecule are:



- ALL amino acids contain an amino group at one end of the molecule and a carboxyl group at the other end.
- A chemical reaction called dehydration synthesis occurs between the amino group of one amino acid molecule and the carboxyl group of another resulting in a larger molecule called a dipeptide made up of 2 amino acid molecules.
- The chemical bond joining the 2 amino acid molecules is called a peptide bond.

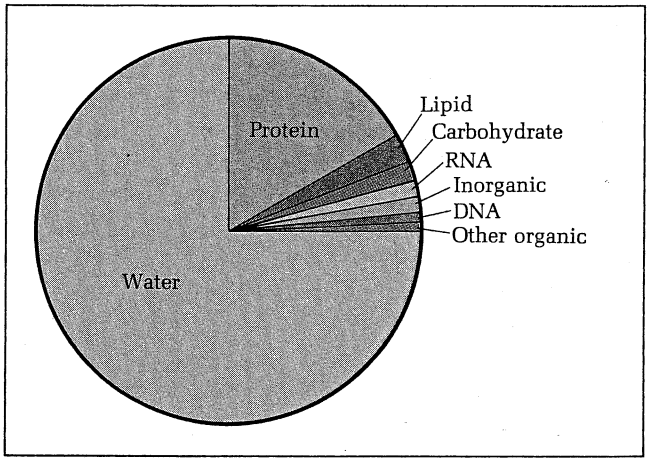


The building of a dipeptide through dehydration synthesis



A Plethora of Proteins

- Proteins are the most numerous , abundant and diverse molecules in a cell and account for ***two-thirds*** of cell's dry weight.



- There are 20 different kinds amino acid molecules which can combine to form an incredible number of proteins.

ANALOGY - *amino acids : proteins* ***AS*** *letters : words*

- The basis for this variability include differences in the number , kinds and sequence of amino acids in the resulting protein **MACRO**molecule.

Some Very Important Protein Molecules Include:

Protein	Function
Hemoglobin	**Carries oxygen in the blood.**
Hormones	**Allows for the communication between body cells.**
Neurotransmitters	**Allows for the communication between nerve cells.**
Antibodies	**Attack and destroy pathogens that enter the body.**
Enzymes	**Increase the rate of chemical reactions in the body.**

(5) *Adenosine TriPhosphate = ATP* *(Textbook pp.108-109)*

- Produced in cell by the process of cellular respiration

CHEMICAL REACTION for CELLULAR RESPIRATION:

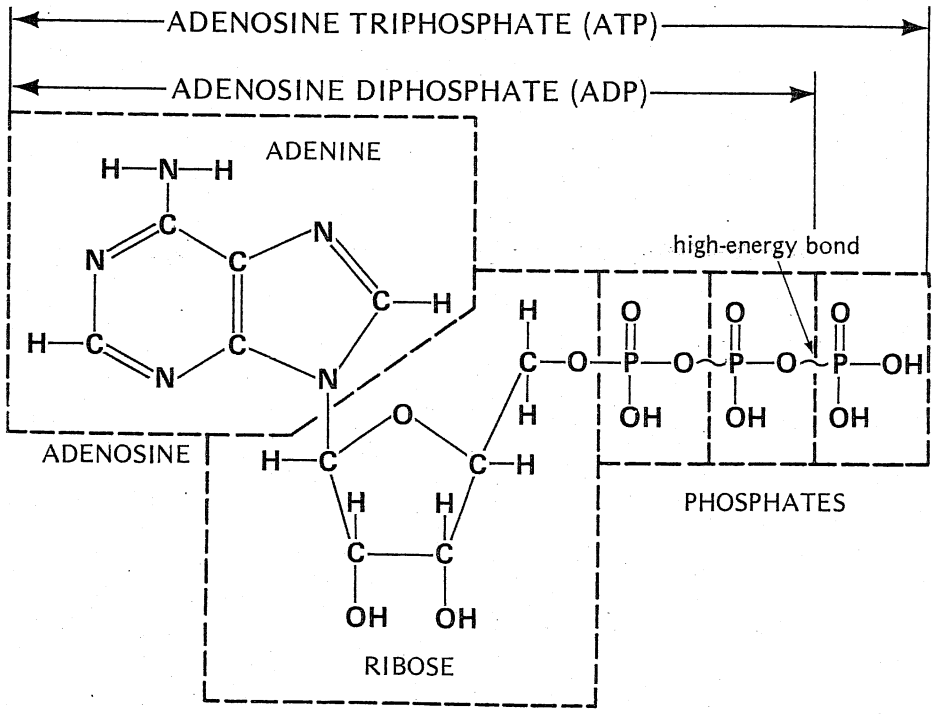
$$C\,H\,O + \_O \longrightarrow \_CO + \_H\,O + \_\_\_ ATP$$

C = ____
H = ____
O = ____

C = ____
H = ____
O = ____

Structure of Adenosine TriPhosphate:

- When glucose is broken down during cellular respiration, the energy released is used to attach a 3rd phosphate group to ADP to form ATP.When the third phosphate group is removed from ATP, chemical energy is released. The remaining molecule, Adenoside DiPhosphate or ADP, has only 2 phosphate groups. ADP has less energy than ATP.



ATP is EN-ER-GY!