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Doctor 2022 – Medicine – MU

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Objectives of the lecture:

1- To know what is meant by biochemistry

2- To understand the relationship between biochemistry and the other sciences

3- To explore the importance of biochemistry in understanding the causes of different diseases

4- To interrelate between the uses of biochemical testing and diseases

Biochemistry {specialized type of chemistry}

- It is the application of chemistry to the study of biological processes (structure, composition and chemical reactions of substances in living systems {from simplest level (one cell, called unicellular ex: bacteria) to more complex level(multicellular)} =living organism) at the cellular and molecular level.

- The combination between chemistry, physiology and biology allows investigating the chemistry of living systems by:

A. Studying the structure (Consists of different atoms H, O, N, C Etc...) and behavior of the complex molecules found in biological material can be found in Individual Form or in complicated form

EX: Glucose is the main source of energy in the cell of all living organism

Glucose Can Be Found In:

1)Individual form

2)catabolize will be oxidized to produce the energy needed for all activity

3)different form like: glycogen store; form of glucose in liver and muscle, also in competition with other molecules ex: * lipid +glucose =glycolipid *protein + glucose=glycoprotein

Each of them has specialized function in the cell

B. **The ways these molecules interact to form cells, tissues**

and whole organism.

biochemistry can't be studied alone, but it should be in 1) combination with other subjects ex, physiology and biology.

2) also there is cooperation between biochemistry and other subjects ex: A*cell biology {that studies the structure, function, and behavior of cell ; that is very important, because we have to detect which action take place in which part site of cell.

B*molecular biology { Molecular biochemistry focuses on macromolecules, such as viruses, or enzymes, or more specifically, their function and structure; molecular biology is also incorporated because it is involving genes, which a specific part of the gene can produce a specific type of proteins that could be enzyme, hormone, carrier protein, combination with lipid, carbohydrate etc...}
So we can understand the behavior of different types of protein that produce different type of gene }

C*molecular genetics {location of gene on one particular chromosome (~1000 genes) and it is very important to know their location in chromosome}

Human beings have 20,500 genes &46 chromosomes

All these descriptions involve the macromolecules (proteins, carbohydrates, fats, nucleic acids, enzymes etc...) and their building units.

- **Types of biomolecules**

  Simple molecules : Small molecules

- Lipid, phospholipid, glycolipid, sterol

- Vitamin

- Hormone, neurotransmitter

- Carbohydrate, sugar

Monomers: one molecule {can be joined with each other for the formation of polymers } building unit

جزيئات صغيرة تنضم الى بعضها لتكون جزيئات كبيرة

- Amino acids

- Nucleotides

Monosaccharides -

Polymers: monomer+ monomer+ monomer…….

جزيئات كبيرة تتكون من الجزيئيات الصغيرة السابق ذكرها

- Peptides, oligopeptides, polypeptides, proteins

- Nucleic acids, i.e. DNA, RNA

- Oligosaccharides, polysaccharides (including cellulose)

Biochemical reactions

- Metabolism الايض او التمثيل الغذائي : total sum of the chemical reactions happening in a living organism, includes:

A- Anabolism- energy requiring biosynthetic pathways {the source of energy is catabolism process}

Anabolism = بناء

B- Catabolism- degradation of fuel molecules and energy production for cellular function

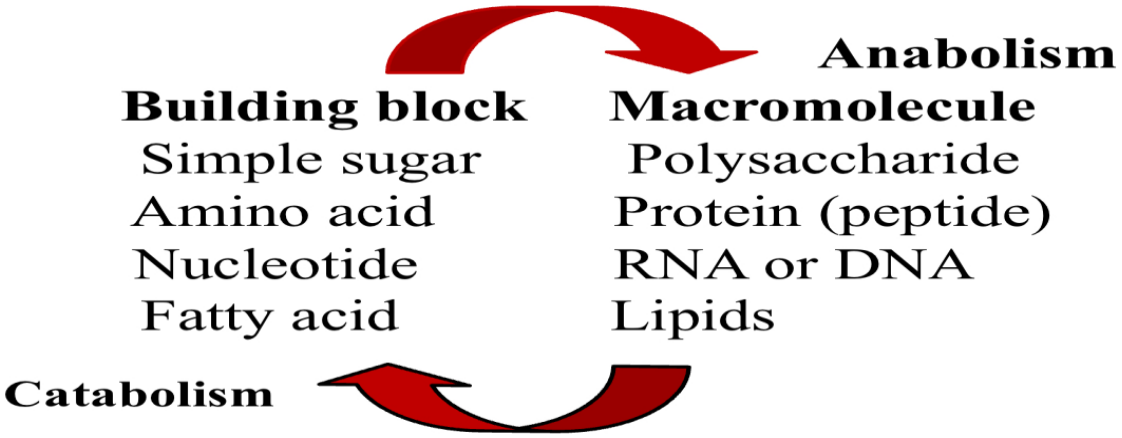
Catabolism = تحطيم {both of the Anabolism & catabolism are Caple with each other }

- Most of the reactions are catalyzed by enzymes

- The primary functions of metabolism are:

- **Utilization of Energy**
- **Synthesis of molecules needed for cell structure and functioning (as proteins, nucleic acids, lipids, & CHO)**
- **Removal of waste products.**

Biomolecules – Structure



اي ان عملية البناء عبارة عن تجميع للوحدات الصغيرة مثل السكريات البسيطة والاحماض الامينية والاحماض الدهنية البسيطة لتكوين مركبات كبيرة ومعقدة مثل السكريات والدهون والبروتينات المعقدة ووالعكس فان عملية التكسير هى تحويل المركبات المعقدة الى مركبات بسيطة

Principles of Biochemistry

- Cells (basic structural units of living organisms) are highly organized and constant source of energy is required to maintain the ordered state.

- Living processes contain thousands of chemical pathways.

- The regulation التنظيم and integration التكامل of these pathways are required to maintain life

- Certain important pathways e.g., glycolysis عملية تكسير وحرق الجلوكوز للحصول على الطاقة is found in almost all organisms.

- All organisms use the same type of molecules:

carbohydrates, proteins, lipids, and nucleic acids.

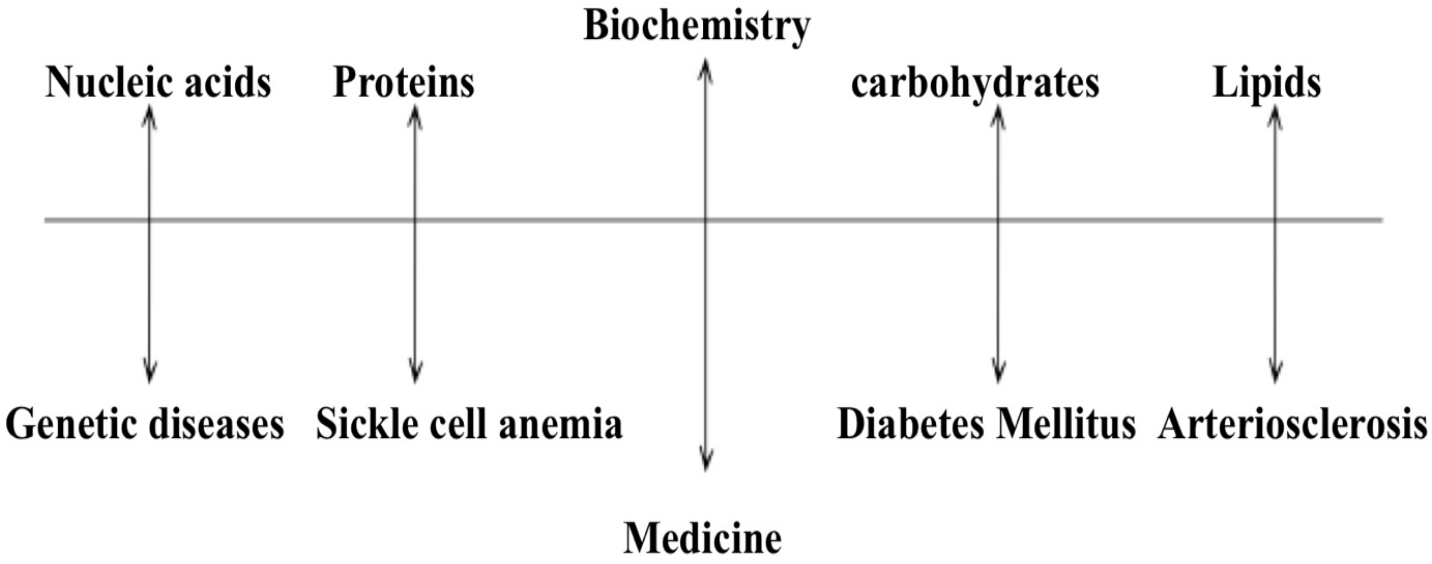
- Instructions اوامر وتعليمات for growth and reproduction التكاثر for each organism is encoded in their DNA

The aim of biochemistry

- **- Is the complete understanding, at molecular level all the chemical processes associated with living cells.**
- **Also, structures and functions, metabolism and its regulation, gene expression modulation and how the life has begun (DNA —> RNA —> Protein)**

- To realize these targets, biochemists have to isolate numerous molecules found in cells, determine their structures, and analyze how they function.
- Many techniques have been used for these purposes as chromatography, electrophoresis, elemental analysis, ultracentrifugation, mass spectrometry and X- ray crystallography
- Some of These techniques is used for separate molecule and some used for analyze molecule but not all.
- تستخدم هذه التقنيات لعرض الجزئيات الحيوية او لفصلها عن بعضها

- The interrelationship علاقة of biochemistry and medicine is a wide two-way street. # مهم



- If we have defect in nucleic acids it will cause genetic disease اذا حدث مشاكل في الاحماض النووية ينتج امراض وراثية
- If we have defect in protein it will cause sickle cell anemia and another group of diseases …etc. واذا حدثت مشاكل في تكوين البروتينات تنتج امراض عديدة مثل انيميا الخلايا المنجلية

Biochemistry; and life sciences

- Genetics; nucleic acids, their structures, and functions constitute the core of genetics. We have to know normal structure, behavior, the biochemical reaction then determine if there are any defect, cause disease

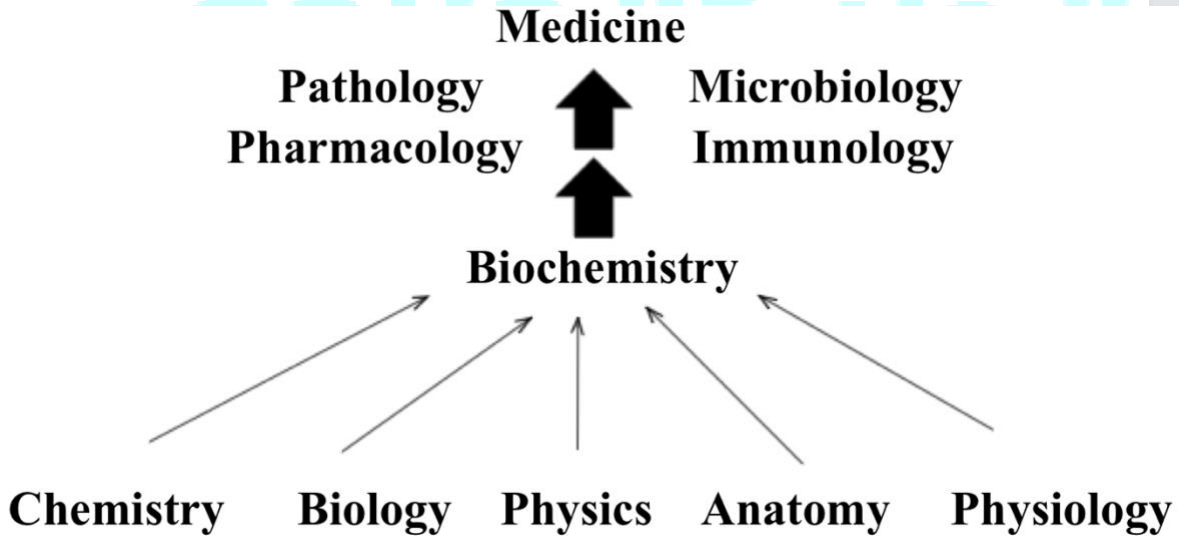
- Physiology and biochemistry overlaps almost completely with physiology علم وظائف الاعضاء (the study of biological processes and functions). Is considered a branch of biochemistry.

- Immunology المناعة ; a science that deals with defense mechanisms طرق الدفاع against diseases, is considered a branch of biochemistry.

- Pathology علم الامراض ; biochemistry explains, at the molecular level, the symptoms and pathogenesis of diseasesالية حدوث الامراض .

- Pharmacology علم الادوية and toxicologyالسموم ; advances in these sciences depend primarily on knowledge gained from biochemistry as drugs and poisons are metabolized inside the body in enzyme-catalyzed biochemical reactions.

- Biological sciences (microbiology علم الاحياء الدقيقة , botany and zoology) use biochemical approaches in the study of different aspects of these sciences



Normal biochemical processes are the basis of health

- World Health Organization منظمة الصحة العالمية (WHO) definition of health (situation in which all intra- and extracellular reactions that occur in the body are proceeding at rates with maximal survival of the organism in the physiologic state).

- ✓ **Groupes of compounds should be supplied in food because our body can't produce them**
  1. **Vitamin except vitamin D**
  2. **Mineral e.g., zinc, iron**
  3. **Essential amino acid**
  4. **Essential fatty acid**
  5. **Water**

Biochemical research, nutrition and preventive medicine

- One major item for the maintenance of health is that there be optimal dietary intake of a number of chemicals; the chief of these are vitamins, certain amino acids, certain fatty acids, various minerals, and water.

- Because much of the subject matter of both biochemistry and nutrition is concerned with the study of various aspects of these chemicals.

- Moreover, the systematic attempts محاولات to maintain health and prevent disease is called (preventive medicine).

- Thus, nutritional approaches depend to a great extent on a knowledge of biochemistry.

Most & perhaps all disease has a biochemical basis

- Most if not all diseases are manifestations اعراض of molecules abnormalities, chemical reactions, or biochemical processes. No disease without biochemical base

- The major factors responsible for causing diseases in animals and

humans are affecting one or more critical chemical reactions or molecules in the body.

The major causes of diseases

1- Physical agents: Mechanical trauma اصابة , extremes of temperature,

Radiation اشعاع cause mutation طفرة in DNA and electric shock.

2. Chemical agents, including drugs and toxic compounds. Have side effect

3. Biologic agents: Viruses, bacteria, fungi فطريات , higher forms of parasites الطفيليات .

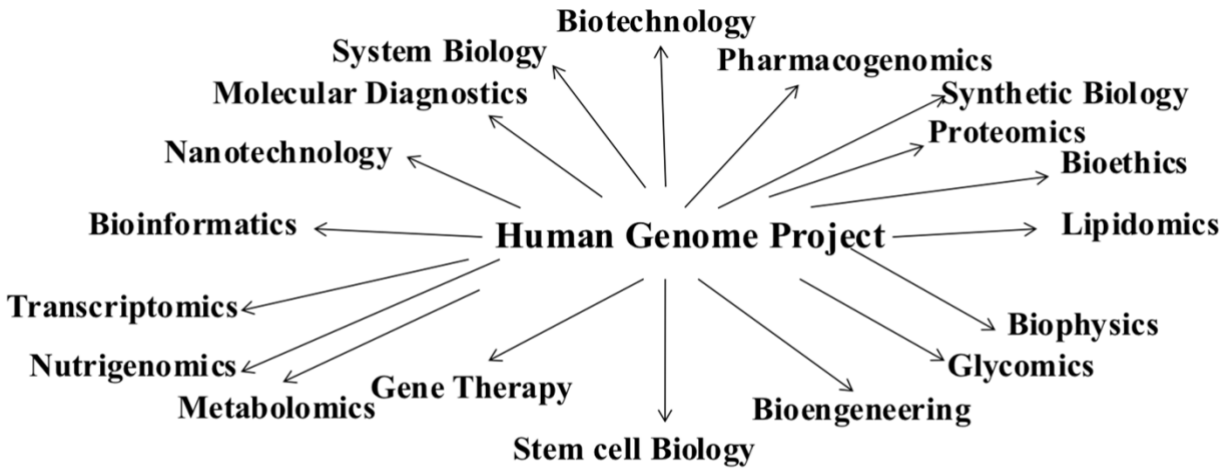
4. Oxygen lack نقص الاكسجين : Loss of blood supply, depletion نفاذ of the oxygen-carrying capacity of the blood, poisoning of the oxidative enzymes. E.g. in covid-19 when defect in function of lungs the amount of O2 reaching to cell is too little, cause shifting in metabolism from aerobic state to non-aerobic condition, the result produce a lactic acid مثل ما يحدث في الاصابة بالكورونا يحدث نقص في وظائف الرئة فيقل الاكسجين الواصل للخلايا ويتحول التمثيل الغذائي داخل هذه الخلايا من تمثيل غذائي في وفرة الاكسجين الى صورة اخري في وجود نقص الاكسجين

5. Genetic disorders: Congenital, molecular.

6. Immunologic reactions: Anaphylaxis, autoimmune disease الامراض التى تحدث نتيجة هجوم الجهاز المناعي علي انسجة الجسم .

7. Nutritional imbalances: Deficiencies, excesses.

8. Endocrine imbalances: Hormonal deficiencies, excesses.



- The Human Genome Project (HGP) has influenced many disciplines and areas of research. Biochemistry was underway long before the HGP commenced.
- However, a number of the disciplines shown (e.g., bioinformatics, genomics, glycomics, lipidomics, metabolomics, molecular diagnostics, proteomics, and transcriptomics) are very active areas of research by biochemists.

Some uses of biochemical laboratory tests in relation to diseases

Use	Example
- To reveal the fundamental causes and mechanisms of diseases	- Demonstration of the causes of genetic defect as in cystic fibrosis (1)
- To suggest rational treatments of diseases based on 1 above *(2)*	- A diet low in phenylalanine for treatment of Phenylketonuria *(3)*
- To assist in the diagnosis of specific diseases	- Use of the plasma enzyme creatine kinase MB (CK-MB) in the diagnosis of myocardial infarction موت جزء من عضلة القلب او ما يسمى مجازا بجلطة في القلب
- To act as screening tests for the early diagnosis of certain diseases	- Use of measurement of blood thyroxine or (TSH) in the diagnosis congenital hypothyroidism. *(4) نقص هرمون الغدة الدرقية*
- To assist in monitoring the progress (e.g, recovery, worsening, remission, or relapse) of certain diseases	- Use of the plasma enzyme ALT in monitoring the progress of infectious hepatitis *(5) الالتهاب الكبدي*
- To assist in assessing the response of diseases to therapy	- Use of measurement of blood CEA in patients who have been treated for cancer colon. *(6)*

(1)a defect (mutation) in a gene (CFTR) gene in chromosome 7

(2) especially in inherited diseases (genetic disorder) e.g. Phenylketonuria, Alkaptonuria, Primary hyperoxaluria Galactosemia

(3) The problem is caused by a gene responsible for producing a specific enzyme called phenylalanine hydroxylase (PAH) gene and these enzyme contributes in a metabolism of a certain amino acid called phenylalanine .SO as a result to deficiency in these enzyme you have to take diet with low in phenylalanine to reduce phenylalanine build up in the body because it cause mental Retardation

(4) complication mental Retardation

(5) Alanine aminotransferase (ALT) or called glutamic pyruvate transaminase to monitoring the progress of certain diseases

(6) a common approach to cancer treatment surgical resection of cancer colon but we have to do follow up ,by measure one of the tumor marker ,{CEA) a carcinoembryonic antigen test is a blood test used to help diagnose and manage certain types of cancers.

References

1- **Harper's Illustrated Biochemistry, 29th edition**
2- **Lippincott illustrated biochemistry, 5th edition**
3- **Biochemistry, Stryer, 8th edition**

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"إنَّ منْ أعظَم ما يُعين النَّفس علىٰ تحمّل هَذا التعَب الذِي تتطَلبه المَعالِي؛ أنْ يستحضِر المَرْء الثمَرة، وأنْ يستدعِي فِي ذهْنِه حُسن العَاقبة، فإنْ الجدوىٰ والمُكتسب تُهوّنان علىٰ النَّفس تَحمّل المَشاق والتعَب.
كَما يقُول ابنُ الجَوزي فِي استعَارة مُكثفة: "تَلمَّح فَجرَ الأَجرِ يَهُن ظَلامُ التكليفِ".
#لجنة_الطب_والجراحة