

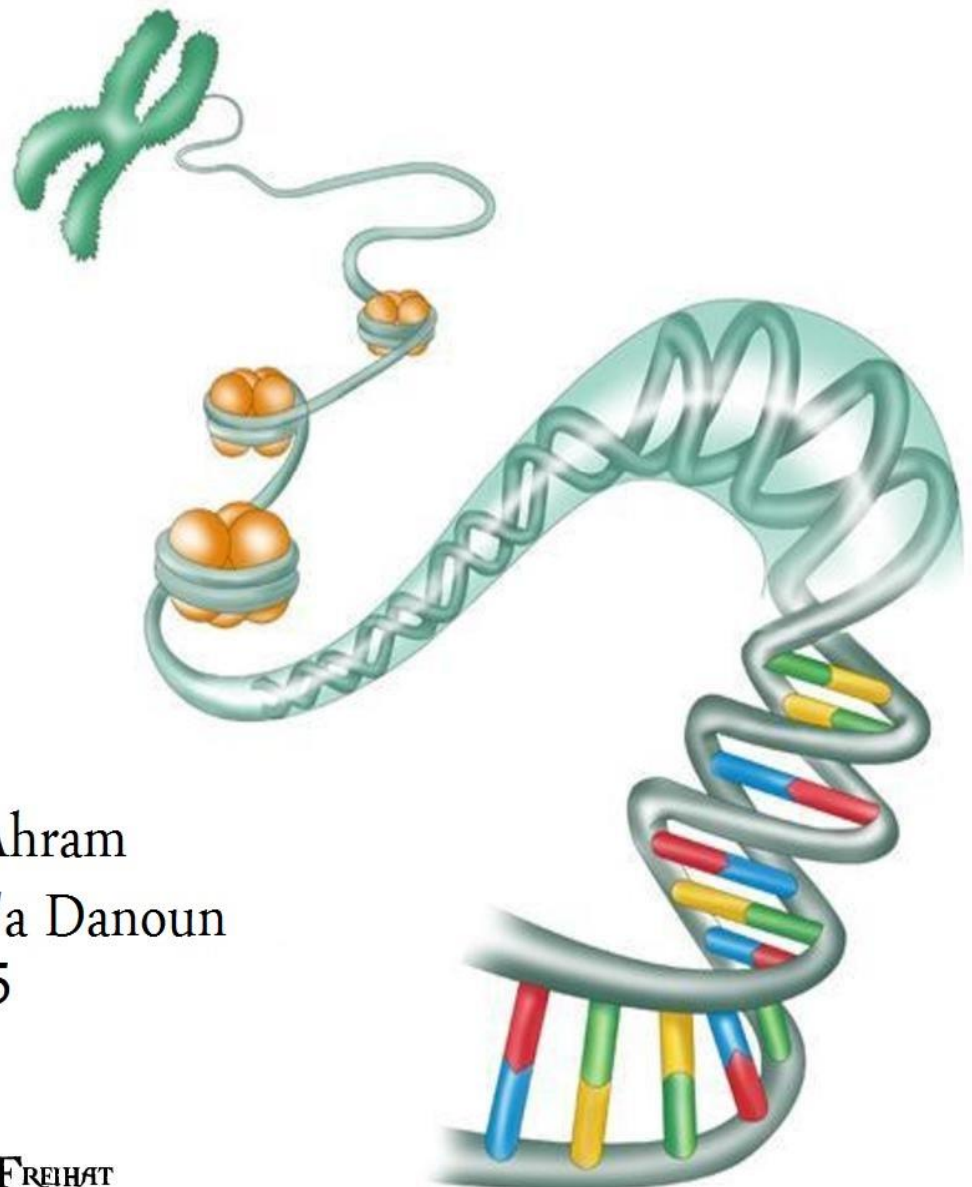


UNIVERSITY OF JORDAN  
FACULTY OF MEDICINE  
BATCH 2013-2019



# GENETICS & MOLECULAR BIOLOGY

☐ Slides ☒ Sheet ☐ Handout ☐ other.....



**Lecture # 1**

**Title:**

**Dr. Mamoun Ahram**

**Done By: Bara'a Danoun**

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DESIGNED BY NADEEN AL-FREIHAT

## *Introduction to Principles of Genetics and Molecular Biology*

### Cell biology

- We all started from ONE single cell then we evolved somehow (the doctor says that he believes in that).
- The doctor say that we didn't originate from monkeys, it's a lie (no one says that by the way) .

قَالَ رَبُّنَا الَّذِي أَعْطَى كُلَّ شَيْءٍ خَلْقَهُ ثُمَّ هَدَى

- ALLAH creates the tools for creation, for evolution . So it's a process of evolution (evolution ويربطها بكلمة "ثم هدى" الى "ثم هدى" . (د.مأمون يشير الى

﴿ اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ ﴿١﴾ خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ ﴿٢﴾ بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ ﴾

- If you want to really know god ,you need to understand creation .

Now it's a fact that creation started from water as Qura'an indicates :-

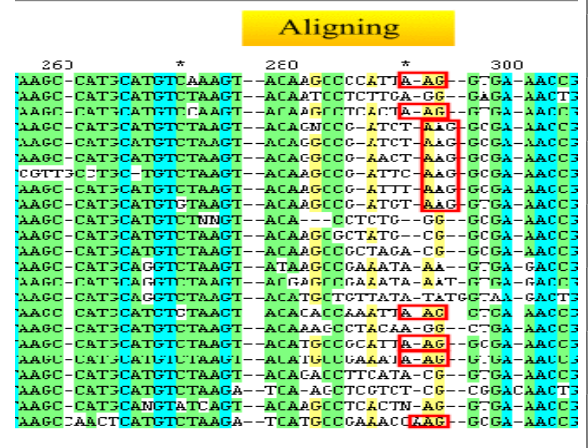
"وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ"

- The material that we are created from is (water), also indicates the place that we are created in .
- So you should think critically, evolution is a fact .
- Dr thinks that it's not a universal ancestor , rather it's a universal ancestorS (collection of ancestors not just one) .But eventually there is different types of cells :bacteria , eukaryotes and another Kingdome known as Archaeobacteria .
- Archaeobacteria has a combination of eukaryotic and prokaryotic features. We can find many of them living in the Dead Sea ,so the dead sea isn't really dead.

Why evolution is considered as a fact ?

## DNA and protein Homology :

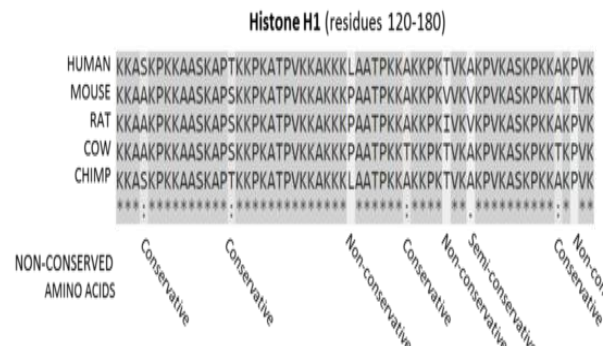
When you compare nucleotides and amino acids sequence of different species (for e.g. :- human DNA with bacterial DNA ) you will find similarity (Homology) sometimes that means they are identical .



So if you look to this picture, you will find that there is things that are common. This is an indication that they are related to each other. So DNA homology and protein is basically looking for similarity in nucleotides and amino acids sequence of different organisms from different species in order to compare the DNA of humans with other organisms and you will notice so many similarities between them.

## Humans and others

If you compare DNA sequence of Histone H1 (which is a DNA binding protein and it's a highly conserved protein among mammals, vertebrates) with rats, you'll find so many similarities, they differ only in a few amino acids. This is an indication that we are all related , it doesn't make us less than human being ,we are higher than that , it's just to give an idea .

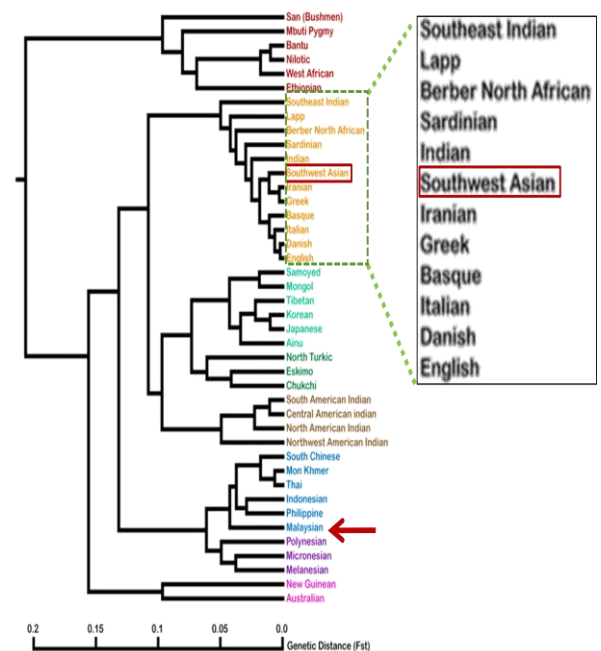


Scientists use similarities in DNA sequence to see how people are related to each other , they find out that:- "*Arabia was indeed the first staging post in the spread of modern humans around the world.*"

French newspaper has a headline says that: - "*We are all Arabs!*"

**Let** us suppose that you discover a new protein (a new gene) and you want to know the function of this protein, What do you do? You compare DNA sequence of this protein with other proteins (so you do DNA homology analysis ). Let's say that this protein you discovered is similar to a bacterial enzyme, that's tell you that this protein works similar to that bacterial enzyme .

**SO you test the function of protein by doing an enzymatic assay .**



## Genetic relatedness of world populations

Prof.Karadsheh collected DNA samples from Jordanian and other groups.

To know what the origin of Jordanian. Or what the origin of the other groups and to know the relationship between Jordanian and the other groups.

They find that Jordanians are related to other population of the area like Syrians, Saudi, Palestinian ...etc .

But amazingly they find out that there is a high similarity in the DNA sequence between Jordanian and a group of Spanish population located in northern Spain than other European and other Spanish population .

**The reason is :**

Umayyad conquest of Hispania (الفتح الاسلامي للأندلس)

where a group of Jordanian army invade Spain and they are relocated to northern Spain .

Also they find that there is high similarity between Jordanian and Orcadians (which is an island located in Scotland) .

*Another group of scientist compared DNA of Palestinians and other world populations , but the study retracted -it does not exist anymore- , because Jews didn't like it because the study shows that Palestinians are related to Jews which means that Jews aren't better.*

We all evolved from universal ancestor , the idea is that the basic unit of life is the cell (not the DNA) . So we can use cell to study human disease and human biology; because we are all related. We call this a Model system ( we use a model system that resemble human cells ) .

The most famous Model system is E.coli (a bacteria that cause food poisoning) because of its features :-

- Simple .
- Rapid growth( divide every 20 minutes ) . Starting from one cell , then (after a certain time ) you will find billions of cells .
- Has a small genome.
- They are the ideal models to study the basics of biochemistry and molecular biology ; It has 4.6m base pairs/4300 genes/1 chromosome and a lot of plasmids .
- The genes of this organism can be easily manipulated (changed) .


Few years ago instead of using electrical wire (for e.g. : copper ) to transmit signals, they tend to use living system to transmit a signal from one wire end to the other end; because model system transmit signals faster than the movement of electrons .

*But They cannot be used to study aspects of **eukaryotic** cell structures and functions ( they don't have a nucleus and other organelles ).*



That's why they move to another model system which is **Yeast** .

**NOTE** : From this page until the end of the sheet most of the information exist in the slide .

This symbol  indicates extra information doctor add them in the lecture \* they are not in the slide \* .

## Yeast

- The **simplest** eukaryotes with features of eukaryotic cells, it's a single cell, so it's the only eukaryotic organism with single cell ,all other eukaryotic organisms are multicellular.

- ✓ A distinct **nucleus** .

- ✓ They have **cytoskeleton** and other **organelles** .

- Growth is rapid and can be grown in plate like bacteria .

-  (not as rapid as bacteria but still rapid) and as colonies.

- 12 million base pairs of DNA/6000 genes/ 16 **chromosomes** .

Used to understand DNA replication, transcription, RNA processing, protein sorting, and regulation of cell division .

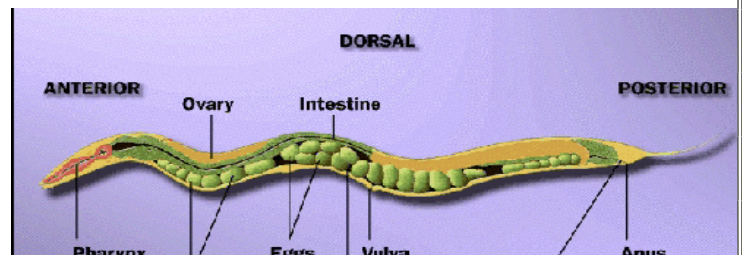


## Dictyostelium discoideum

- A cellular slime mold.
- More complex genome than yeast's, but simpler than that of higher eukaryotes'.
- Can be readily grown in the laboratory and undergo genetic manipulations.
- Highly **Mobile** cells used to study molecular mechanisms of animal cell movements .
  - Single cells can aggregate into multicellular organism, so you can study the development of one organisms to multicellular organism (formation of multicellular organism from single cells).

## Caenorhabditis elegans

- Really small ,transparent .
- Multi cellular (worm ).
  - More complex eukaryotes .
  - 97m base pairs of DNA/~ 19,000 genes/6 chromosomes ,
  - (The only different between us and it is few thousand genes , we – humans- have 20 -25 thousand genes ) .
  - Motile cells.
  - Have systems (ex; neurological system) ,so you can study cell differentiation and the development of the organism.
  - Easily grown in lab and genetically manipulated.
  - Adult worms consist of only 959 somatic cells ,starting from 1090 cells (the 131 cells that exist in the worms when they are developed and don't exist when they are adults die by **apoptosis** ) .
    - How does that occur? By **apoptosis (programmed cell death)** .
  - Used for studies of animal development and cell differentiation and apoptosis.




## **Drosophila melanogaster**

### **(The fruit fly)**

**-Has 180m base pairs, four chromosomes, 14,000 genes**


 So they differ from us in 6000 genes.


 They have complex organs (eye , nervous system , wings .. ) ; about **100** years ago they study genes located on the chromosomes of these organisms and they are able to know how genes are located on chromosomes and to understand the process of recombination , development and differentiation .

- **It's a nice model system; because it has short life they live for (~ 2 weeks) .**
- **They study development and differentiation** of cells and the process of recombination .

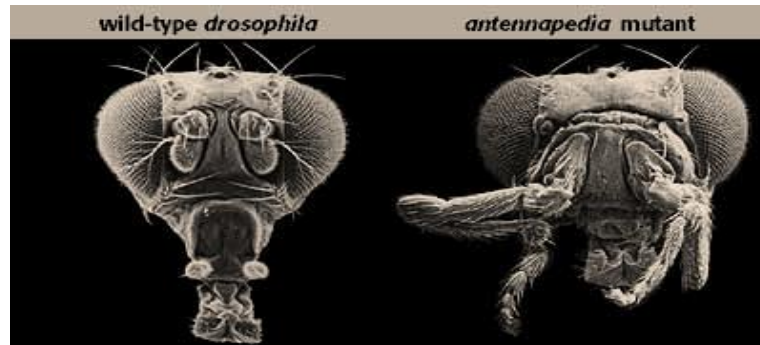
 Scientists use Drosophila to know how cancer cells metastasize .

- **Determine the relationship between genes and chromosomes.**

 What is nice about drosophila is that you can look for the function and location of different proteins, so you can stain protein and look where they are located which tell us something about cell differentiation.

 Do genetic manipulation by inserting gene or activating genes in different regions , so they can have legs coming out of the head , that tell you something about cell differentiation ( this cell must be a leg , this cell must be an arm .. etc ) .





Another thing is that *Drosophila* used to understand symmetry because it has right and left wings.

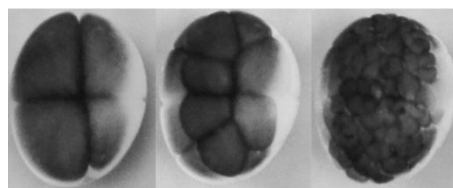
## *Xenopus laevis* (a frog)

A scientific name of a frog .

- Used in studies of vertebrate development.

Because

- *Xenopus* eggs are large and develop outside of the mother , so :-
  - stages of development can be studied in the laboratory.
- Used in studying development, differentiation, and embryonic cell division into different organs.



## Mice

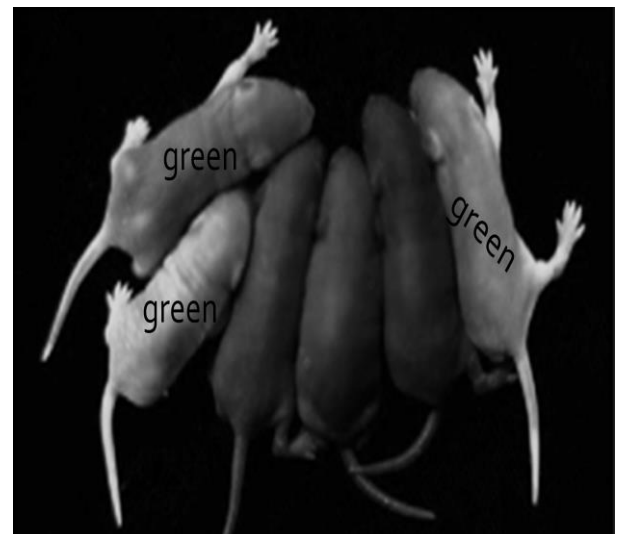
Beautiful model system to study , it's easy to study because :-  
It has 20,000-25,000 genes which is similar to human at DNA level .

Also you can develop Transgenic mice .

➤ What is the meaning of Transgenic mice?

- ◆ Mice with specific mutant (manipulated ) genes , you have a mouse with a gene that shouldn't be there .
- ◆ If you want to know the function of certain gene delete it; so you study the effect of the absence of this gene .
- ◆ For e.g. :- scientists spend many years to create a mouse that doesn't have a certain gene ,they notice that nothing happened, the mouse survive but the mouse is bold ! so could that be the cure of boldness ? Dr.Ma'moun hope so =D .

These mice express certain gene known as ( green florescence gene) this gene is found in sea organism that fluoresce different colors , so they suppose that the gene gives green color, and when they put this gene in the mice and allow the mice to develop, they notice that the mice fluoresce and this will be transfected in every single cell to see how these cells develop and differentiate .




## Cultured mammalian cells :-

 You need to study human being but you can't, what you do?

You isolate certain cells in human being ,culture them and then you manipulate them so that these cells become immortal, (when you take these cells out of human being and grow them in laboratory,\* notice that these cells won't die because they are immortal ) .This is known by cultured cells .


- Can be manipulated under controlled laboratory conditions.
- Uses: many aspects of mammalian cell biology, (DNA replication, gene expression, protein synthesis and processing, and cell division, etc.)

## Viruses :-

 This is the simplest living organism; it consist (minimum) of 3 genes, they only have a protein capsid (coat) and inside it there is a genetic material (DNA or RNA not both) .

- This is an example of bacteriophage (bacterial viruses) that allowed us to understand basic molecular biology and genetics.



 They use viruses in these days in medicine (gene therapy). What they do? They put a gene in a virus that infects the cell and genetic material goes in and becomes a part of a cell .

## Organelles

Organelle	Function
Mitochondrion	transfers energy from organic compounds to <u>ATP</u>
Ribosome	organizes the <u>synthesis of proteins</u>
Endoplasmic reticulum (ER)	prepares proteins for <u>export</u> (rough ER); <u>synthesizes</u> steroids, regulates calcium levels, breaks down toxic substances (smooth ER)
Golgi apparatus	processes and <u>packages</u> substances produced by the cell
Lysosome	<u>digests</u> molecules, old organelles, and foreign substances
Microfilaments and microtubules	contribute to the <u>support</u> , <u>movement</u> , and <u>division of cells</u>
Cilia and flagella	propel cells through the environment; move materials over the cell surface
Nucleus	stores hereditary information in <u>DNA</u> ; synthesizes RNA and ribosomes
Cell wall*	supports and protects the cell
Vacuole*	stores enzymes and waste products
Plastid*	stores food or pigments; one type (chloroplast) transfers energy from light to organic compounds

In plants, humans don't have them

- Humans have cilia in some of their cells, but don't have flagella .
- The Golgi apparatus is responsible for modifying the protein and send it to different parts of the cell .

## Major components of cells : (Macromolecules )

- 1)Nucleic acids (polymer of the monomer nucleotides)
- 2)Carbohydrates (polymer of the monomer –ex ;glucose in the case of starch- )
- 3)Proteins (polymer of the monomer amino acids )
- 4)Lipids (50% of mass of plasma membranes, 30% of mitochondrial membranes ;so they are not equally distributed throughout the cell ) (not a polymer) .

## Composition and properties of membranes :

#what characterizes the cell and the organelles that they are surrounded by a lipid membrane ,ex; cell membrane and mitochondrial membrane that are made of a lipid molecules.

#The different organelles have different components of Macromolecules ,so for example the RBC plasma membrane consists of 40% lipids and 52% proteins , myelin sheet consists of 81% lipids and 19% proteins, mitochondrial inner membrane consists of 24% lipids and 76% proteins.

#lipid classes also are different in composition in different parts of the cell ;

**phosphatidyl ethanol amine** is present highly in the mitochondria , as well as **phosphatidyl cholin** is present highly in the mitochondria and in ER , **glycolipids** are highly present in the myelin sheath

#As you remember from biochemistry that the purpose of having sugar molecules on the surface of cells is cell recognition .

NOTE ;the doctor says that we are responsible only for what is in the slides and what he says in the lectures (sheets) ,the book is only a resource to understand what you don't understand from the doctor .

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*" You are made by god and for god , and until you understand that life will never make sense " .*



*Corrected by :Mohammed Nawaiseh .*