Cytology

Doctor 2019 | Medicine | JU

◉ Sheet ○ Slides

DONE BY

Nada Odeh

CONTRIBUTED IN THE SCIENTIFIC CORRECTION

CONTRIBUTED IN THE GRAMMATICAL CORRECTION

DOCTOR

Dr. Ziad Shraydeh

Scientists & achievements

1/ Spectacles were first made in the thirteenth century (1200)

2/ First compound (double-lens) light microscope >> sixteenth century (1500s)

3/ Using handmade microscopes >> seventeenth century (1600s)

4/ Robert Hooke's achievements

a. The discovery of cells is credited to him

b.(1665) His experiment on cork(part of the bark of trees) which was held to answer his question which was " why stoppers are made of cork ?" . This experiment led him to the discovery of cells which appeared as pores under the microscope , much like honeycomb.

Note : what he actually observed under the microscope was the empty walls of the dead plant tissue which had been originally produced by living cells the surrounded (this makes sense because he studied a tissue which is not a part of the living organism nor represents a group of cultured cells which means the cells were dead)

c. Compound (double - lens) microscope (he used it in the experiment mentioned above)

5/ Antonie Leewenhoek

a. Single-lens microscope >> observe bacteria and other microorganisms

b. First to examine a drop of pond water under the microscope observing microscopic animalcules

c. First to describe various forms of bacteria (from water in which pepper had been soaked / from scrapings from his teeth)

6/ 1830 >> importance of cells was realized

7/ (1838) Schleiden

a. Despite differences in structure of various tissues , plants were made of cells

b. Plant embryo arose from a single cell

8/ (1839) Schwann

a. Published cellular basis of animal life

b. Concluded that cells of plants and animals are similar structures

c. Proposed two tenets of cell theory :

[1] All organisms are composed of one or more cells

[2] The cell is the structural unit of life

9/ (1855) Virchow
Third tenet of cell theory
[3] Cells can arise only by division of preexisting cell
This tenet was added after the acceptance of the proposal which said that organisms arose by spontaneous generation rather than from noncellular materiel as Schleiden & Schwann said
10/ (1969) Levinthal identified features of polypeptides' folding under the title of " Levinthal paradox" *** will be explained later in the sheet
11/ (1891) Driesch >> self regulation experiment on sea urchin
** will be explained later in the sheet

1.1 //The discovery of cells

Cells, and the structures they comprise, are too small to be directly seen, heard, or touched that's way there is a need to use microscopes

cell and molecular biology is reductionist; that is, it is based on the view that knowledge of the parts of the whole can explain the character of the whole .

Higgs boson : hypothesized particle that is proposed to endow all other subatomic particles with mass resulted from the collide of protons with one another at velocities approaching the speed of light (forced by nuclear physicists

Microscopy

Microscope : an instrument that provides a magnified image of a tiny object.

(the rest of paragraph was explained under the title " scientists & discoveries ")

(a)

(b)

Cell theory

The whole concept was explained under the title of " scientists & discoveries "

1.2// Basic properties of cells

(1) life

the most basic property of cells, and cells are the smallest units to exhibit this property.

Related to this property is the ability of the whole cells to grow and reproduce for an extended period of time when cultured outside the organism unlike parts of the cells which deteriorate if isolated . Note that cultured cells die if mistreated

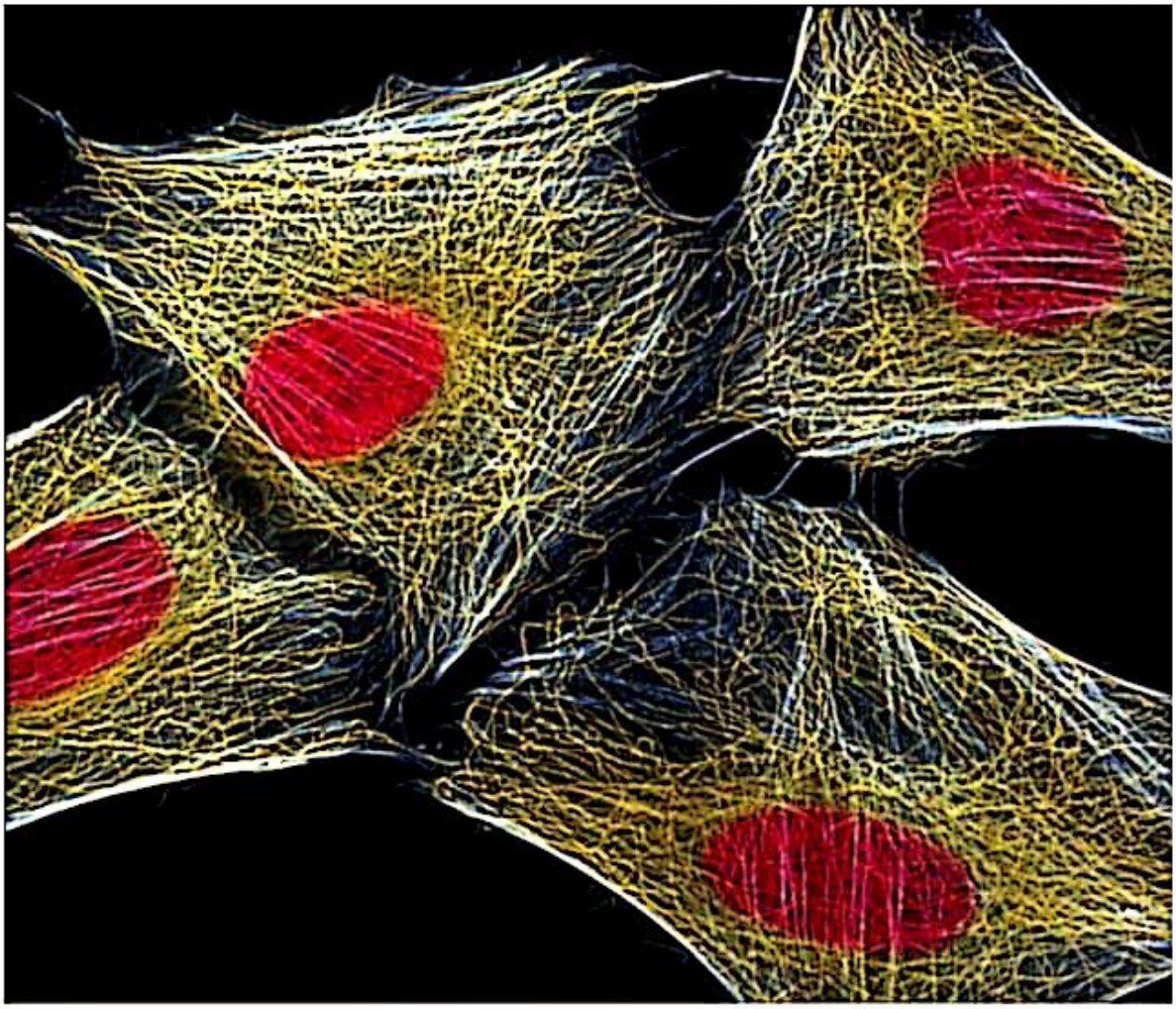
The first culture of human cells was begun by George and Martha Gey of in 1951 and was named HeLa cells after the donor of those cancerous cells Henrietta Lacks .

HeLa cells are still being grown in laboratories around the world today as they can be cultured indefinitely as long as conditions are favorable to support cell growth and division unlike normal cells which have a finite lifetime in culture.

Note :

inside the organism's body (vivo)

Outside the organism's body (vitro (culturing))



(2) Death

one of the most basic properties of life, because only a living entity faces this prospect.
cells within the body that are no longer needed or cells that pose a risk of becoming cancerous eliminate themselves following the instructions of an internal program

(3) Cells are highly complex and organized

A. Complexity
The more complex a structure>>the greater the number of parts >> the less tolerance for errors>> the more regulation or control that must be exerted to maintain the system.
Which means that activities are very precise
Example : DNA duplication occurs with an error rate of less than one mistake every ten million nucleotides incorporated—and most of these are quickly corrected by an elaborate repair mechanism

B. Consistency
1.. consistent appearance under EM
2.. cell's organelles have particular shape and location
3.. each type of organelle has a consistent composition of macromolecules

Figure 1.3

Inset 1 shows epithelial layer of cells that lines the inner intestinal wall.

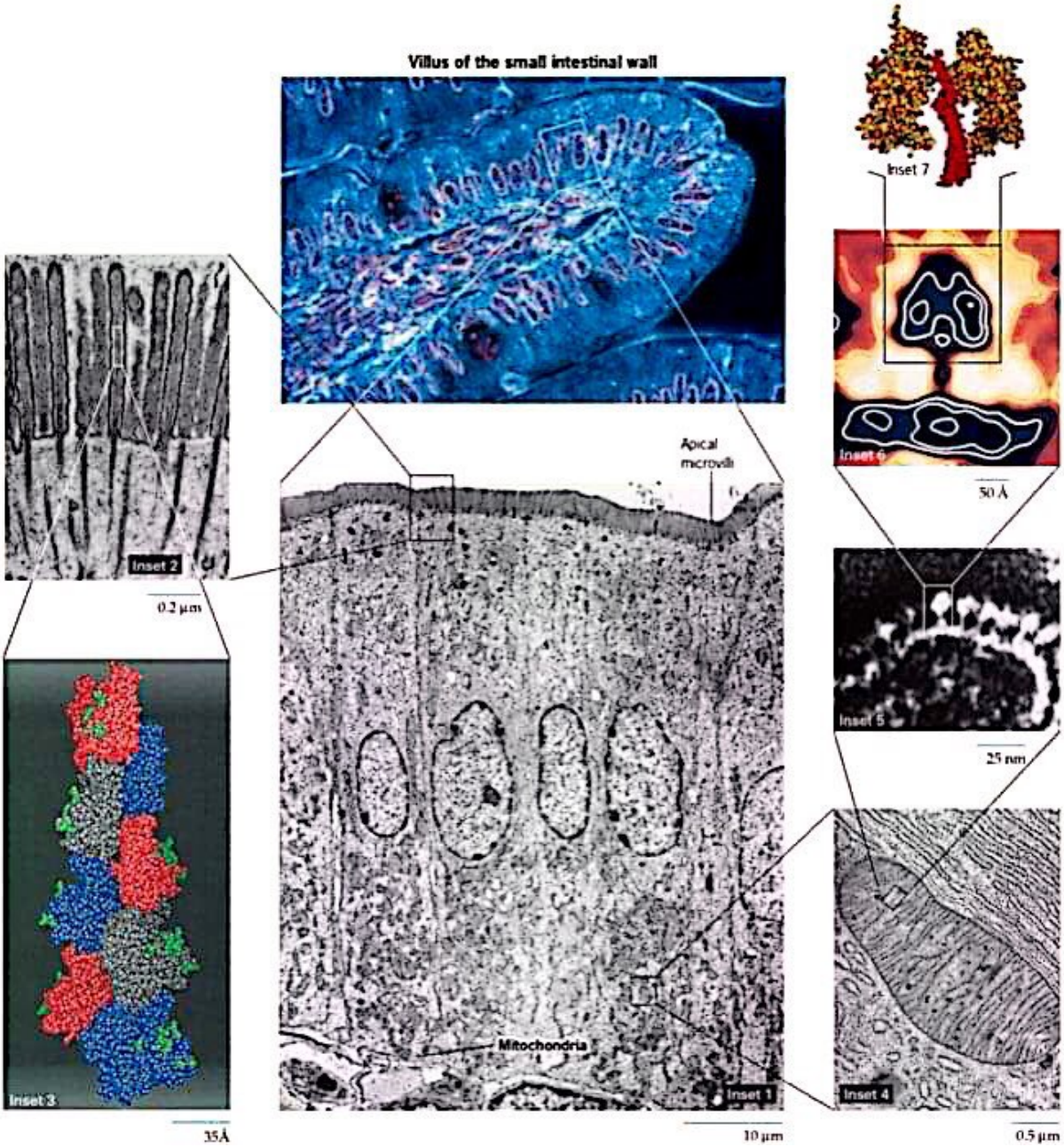
Inset 2 shows the apical microvilli which contain actin filaments facilitate absorption of nutrients

Inset 3 shows the actin protein subunits

Inset 4 shows an individual mitochondrion (there are great quantities of them at the basal ends to provide the energy required to fuel various membrane transport processes.

Inset 5 shows a portion of an inner membrane of a mitochondrion where ATP is synthesized

Insets 6 and 7 show molecular models of the ATP- synthesizing machinery



C. Organization at many different scales using physical processes that are essentially random

Even though living cells are highly complex and ordered random (stochastic) events play a critical role in all cellular activities as many of the molecules within living cells are in a constant state of random movement, propelled by thermal energy they acquire from their environment.

Polypeptides' folding (Levinthal paradox)

If protein folding depended solely on random molecular movements, it would require a period of time greater than the age of the universe for a protein to fold into its native structure. Even though folding of a protein is driven by random thermal motion, the process occurs in stepwise fashion so that the protein folds along pathways in which less structured intermediates guide the formation of better formed subsequent intermediates.

Final conclusion : such events (like polypeptide folding) are "biased"; they depend upon random activities, but they lead to directed outcomes because they select for intermediate stages that lie on the path leading to the desired outcome.

*** Remarkably similar basic processes in all living organisms : synthesis of proteins, the conservation of chemical energy, or the construction of a membrane.

(4) Cells possess a genetic program and the means to use it

*Organisms are built according to information encoded in a collection of genes, which are constructed of DNA.

*Vast amount of information is packaged into a set of chromosomes that occupies the space of a cell nucleus

** Genes' importance :

1- storage lockers for information

2- constructing cellular structures

3- running cellular activities

4- running the program for making more of themselves.

** mutations : The molecular structure of genes allows for changes in genetic information these changes are called mutations

Mutations lead to variation among individuals, which forms the basis of biological evolution.

(5) Cells are capable of producing more of themselves

Individual cells reproduce as individual organisms do .

Cells reproduce by devision ; a process in which the con- tents of a "mother" cell are distributed into two "daughter" cells.

Each daughter cell receives complete and equal share of genetic information (as genetic material is faithfully duplicated) and in most cases both daughter cells have almost equal volume

Figure 1.4
Unequal devision of human oocyte such that
One cell retain nearly all of the cytoplasm and only half of the genetic material
Other cell nonfunctional remnant that consists almost totally of nuclear material

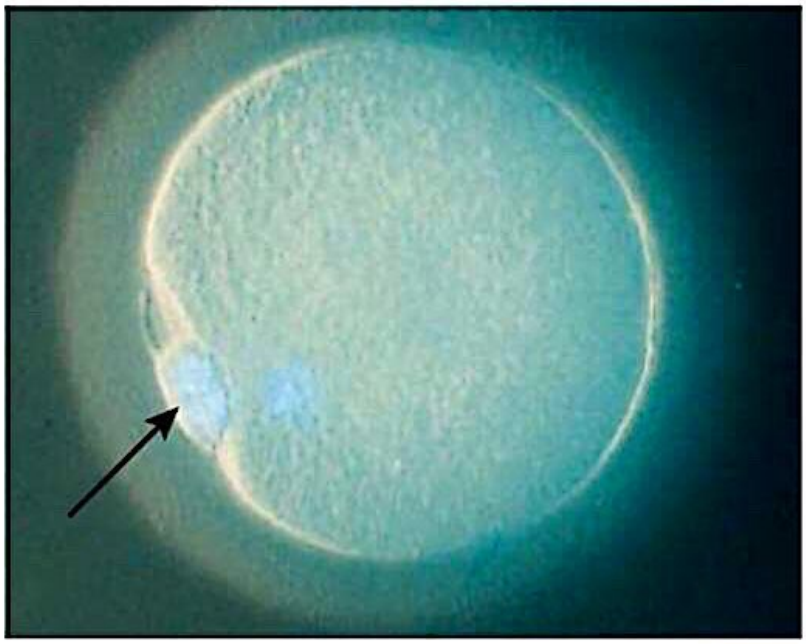


FIGURE 1.4 Cell reproduction.

(6) Cells acquire and utilize energy

Every biological process requires the input of energy.

Energy :

Arrives in the form of electromagnetic radiation from the sun.

Trapped by light-absorbing pigments present in the membranes of photosynthetic cells .

Converted to chemical energy by photosynthesis.

Stored energy-rich carbohydrates.

Energy- rich carbohydrates are disassembled in such a way that its energy content can be stored in a readily available form (usually as ATP)

** energy rich carbohydrates are released by the liver in humans .

The continual " turnover" (breaking down and rebuilding the macromolecules and organelles continually) face of inevitable wear and tear and enables the cell to respond rapidly to changing conditions.

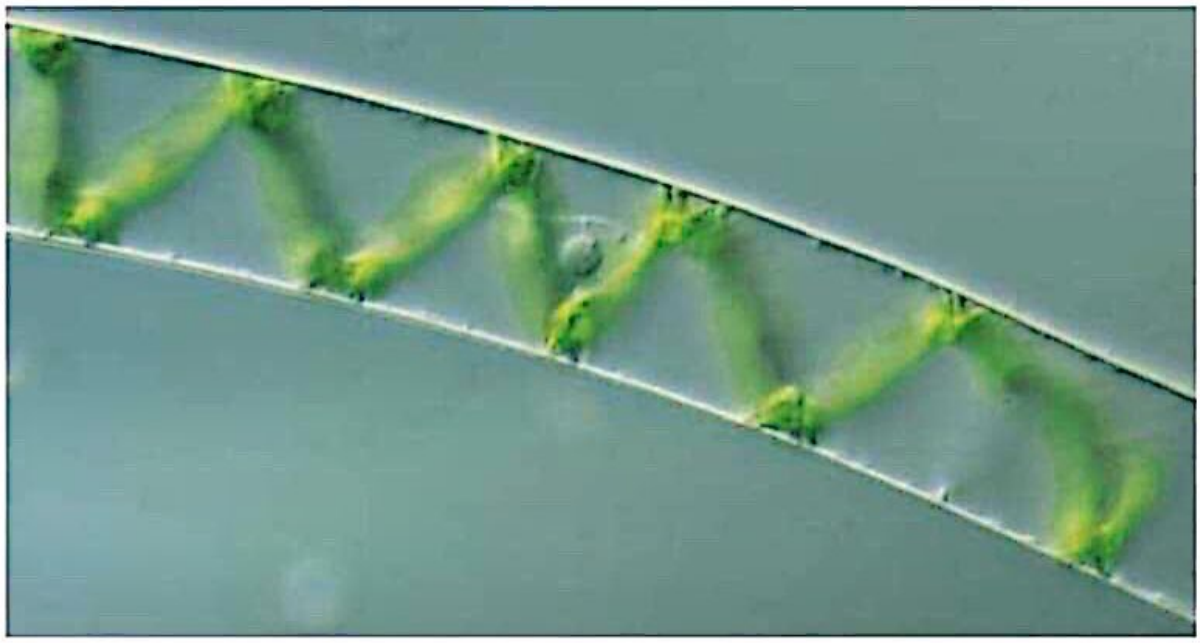


FIGURE 1.5 Acquiring energy.

(7) Cells carry out a variety of chemical reactions

** Even the simplest bacterial cell is capable of hundreds of different chemical transformations

** Virtually all chemical changes that take place in cells require enzymes

Enzymes: molecules that greatly increase the rate at which a chemical reaction occurs.

** Metabolism: The sum total of the chemical reactions in a cell .

(8) Cells engage in mechanical activities

Mechanical activities :

- transportation from place to place
- Assembly and disassembly of structures
- Entire cell movement

All these activities are based on dynamic mechanical changes and done with the help of motor proteins which are one of many types of molecular machines.

(9) Cells are able to respond to stimuli

Cells respond to stimuli:

1- in obvious ways

like single-celled protist by moving away from an object in its path or moves toward a source of nutrients

2- less obvious ways

like multicellular cells as most cells are covered with receptors that interact with substances like hormones , growth factors , extracellular materials as well as substances on the surface of other cells .

Responses to stimuli:

1- altering the cells' metabolic activities

2- moving the cell from one place to another

3- causing the cell to commit suicide

(10) Cells are capable of self-regulation

Cells are robust (hearty and durable) because they are protected from dangerous fluctuations in : 1- composition / 2- behavior

by feedback circuits which return the cell to the appropriate state

Maintaining ordered state requires :

1- energy

2- constant regulation

** the importance of the regulatory machinery becomes evident when they break down , an example on this :

failure of a cell to correct a mistake when it duplicates its DNA may result in:

1- a debilitating mutation

2- a breakdown in a cell's growth-control safeguards can transform the cell into a cancer cell

3- capability of destroying the entire organism.

Figure 1.6
Sea urchin (قنفذ البحر)

The left panel depicts the normal develop- ment of a sea urchin in which a fertilized egg gives rise to a single embryo. The right panel depicts an experiment in which the cells of an early embryo are separated from one another after the first division, and each cell is allowed to develop in isolation. Rather than developing into half of an embryo, as it would if left undisturbed, each isolated cell recognizes the absence of its neighbor, regulating its development to form a complete (although smaller) embryo.

توضيح :

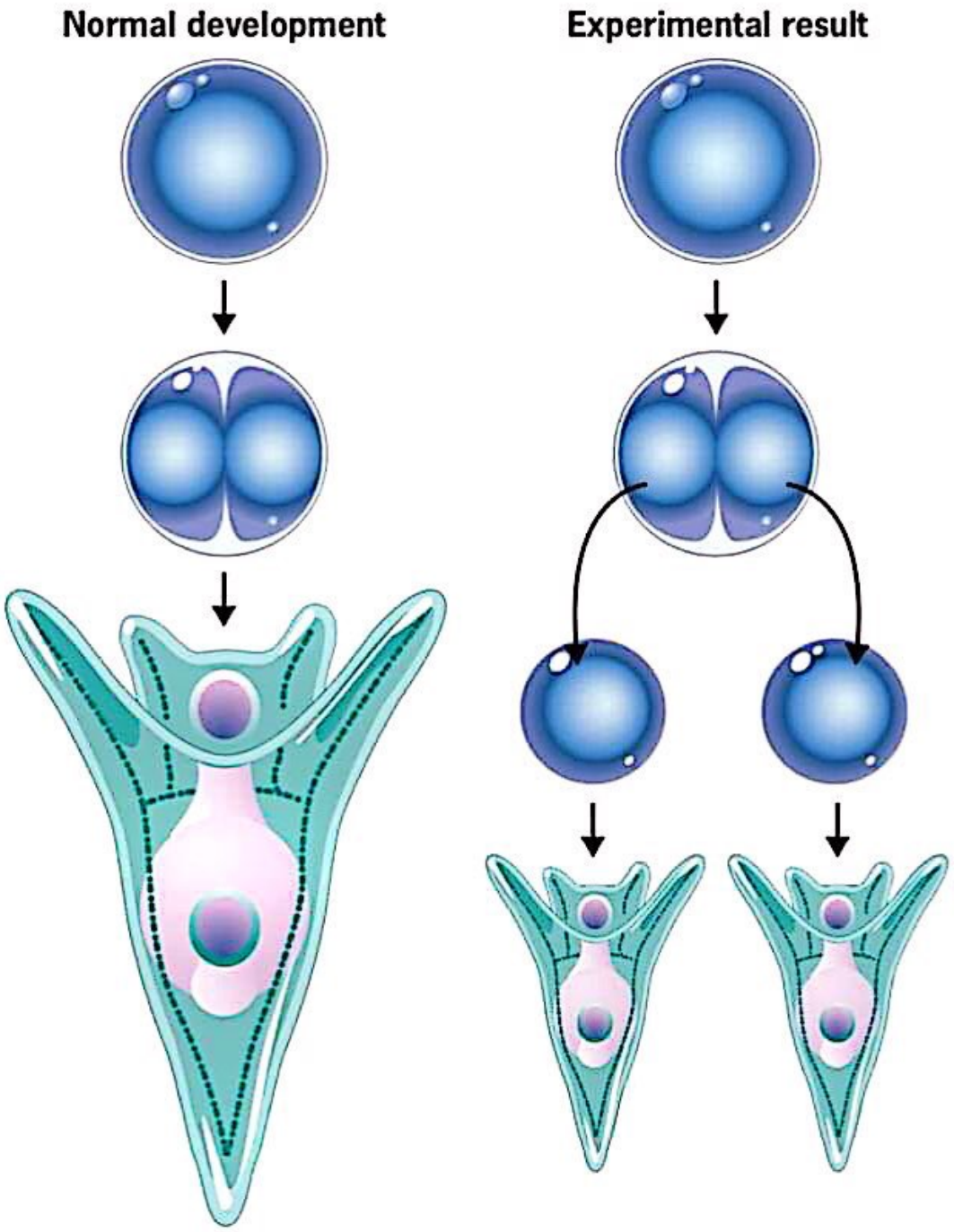
بتوضح التجربة ال self regulation
الصورة اللي على اليسار بتوضح التطور الطبيعي للبويضة المخصبة حيث يؤدي انقسامها
(انقسام متساوي) لتكوين خليتين دون عزلهماعن بعضهما لإنتاج / ظهور جنين واحد
الصورة اللي على اليمين ، تم عزل الخليتين بعد الانقسام الأول ، و حيث أنه الخليتين بالصورة اللي عل
ى اليسار كونوا جنين واحد (يعني كانت كل خلية مسؤولة عن تكوين نصف الجنين) كان يفترض كل
خلية معزولة تكون نصف جنين كأنه ما صار شيء (كأنه ما في عائق وهون تمثل عملية عزل الخليتين
عائق) و لكن بالمقابل كل خلية قدرت تتعرف على فكرة غياب الخلية المكملة للنمو و نظمت نموها
بشكل ذاتي وطبيعي بحيث شكلت كل خلية جنين واحد كامل رغم أنه أصغر بالحجم

The isolated cell here was able to :

1- form an entire embryo although it is normally destined to form only part of it

2- recognize the absence of its neighbors (other cells produced from division) and allow this recognition to redirect the entire course of the cell's development

So it is obvious that this isolated cell (which represents part of the embryo) has a sense of the whole (complete embryo)



In the cell , the information resides in the nucleic acid and the proteins represent the construction workers (functional molecules) .

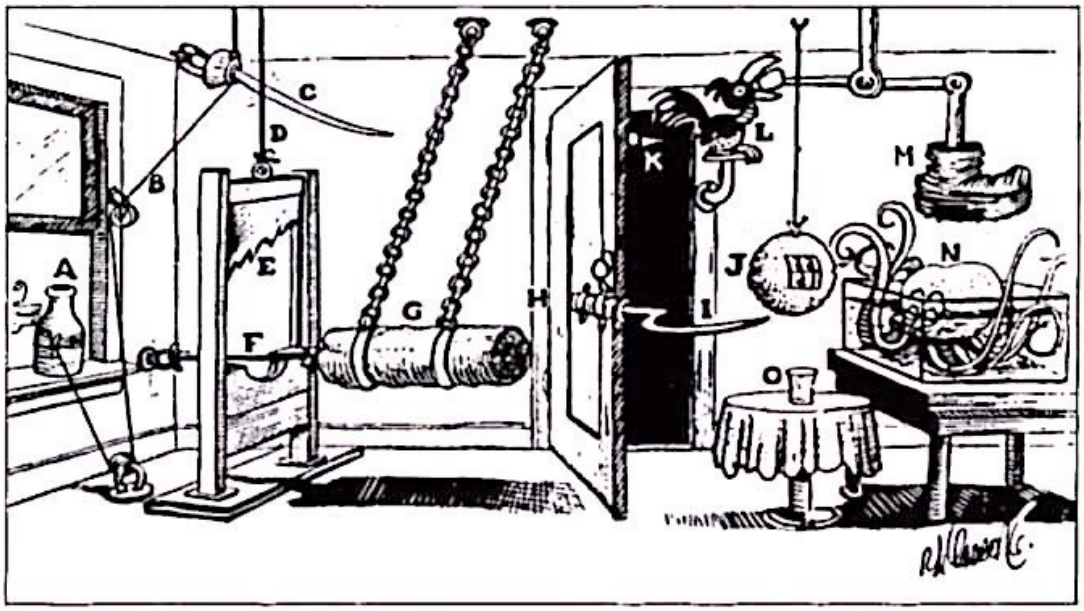
It is the presence of these two types of macromolecules that, more than any other factor, sets the chemistry of the cell apart from that of the nonliving world.

** proteins must act without the benefit of conscious direction. Each step of a process must occur spontaneously in such a way that the next step is automatically triggered.

** each type of cellular Each type of cellular activity requires a unique set of highly complex molecular tools and machines

*** Primary goal of biologists to understand and explain structure, role , mechanisms and interactions related to cells .

Orange Juice Squeezing Machine



Professor Butts steps into an open elevator shaft and when he lands at the bottom he finds a simple orange squeezing machine. Milkman takes empty milk bottle (A), pulling string (B) which causes sword (C) to sever cord (D) and allow guillotine blade (E) to drop and cut rope (F) which releases battering ram (G). Ram bumps against open door (H), causing it to close. Grass sickle (I) cuts a slice off end of orange (J)–at the same time spike (K) stabs "prune hawk" (L) he opens his mouth to yell in agony, thereby releasing prune and allowing diver's boot (M) to drop and step on sleeping octopus (N). Octopus awakens in a rage and, seeing diver's face which is painted on orange, attacks it and crushes it with tentacles, thereby causing all the juice in the orange to run into glass (O).

Later on you can use the log to build a log cabin where you can raise your son to be President like Abraham Lincoln.

(11) Cells evolve

** It is presumed that cells evolved from some type of precellular life form which evolved from nonliving organic materials that were present in the primordial seas.

** prokaryotic cells and eukaryotic cells share many features.However, differences exist .

** LUCA (last universal common ancestor) : single, common ancestral cell from which all living organisms have evolved , lived more than three billion years ago and gave rise to all the living organisms that we know .

** evolution is not simply an event of the past, but an ongoing process that continues to modify the properties of cells that will be present in organisms that have yet to appear.

For example, evolution of drug resistance in bacteria.

The end

Always remember that :"Success is not final; failure is not fatal: It is the courage to continue that counts"

I wish you all the best