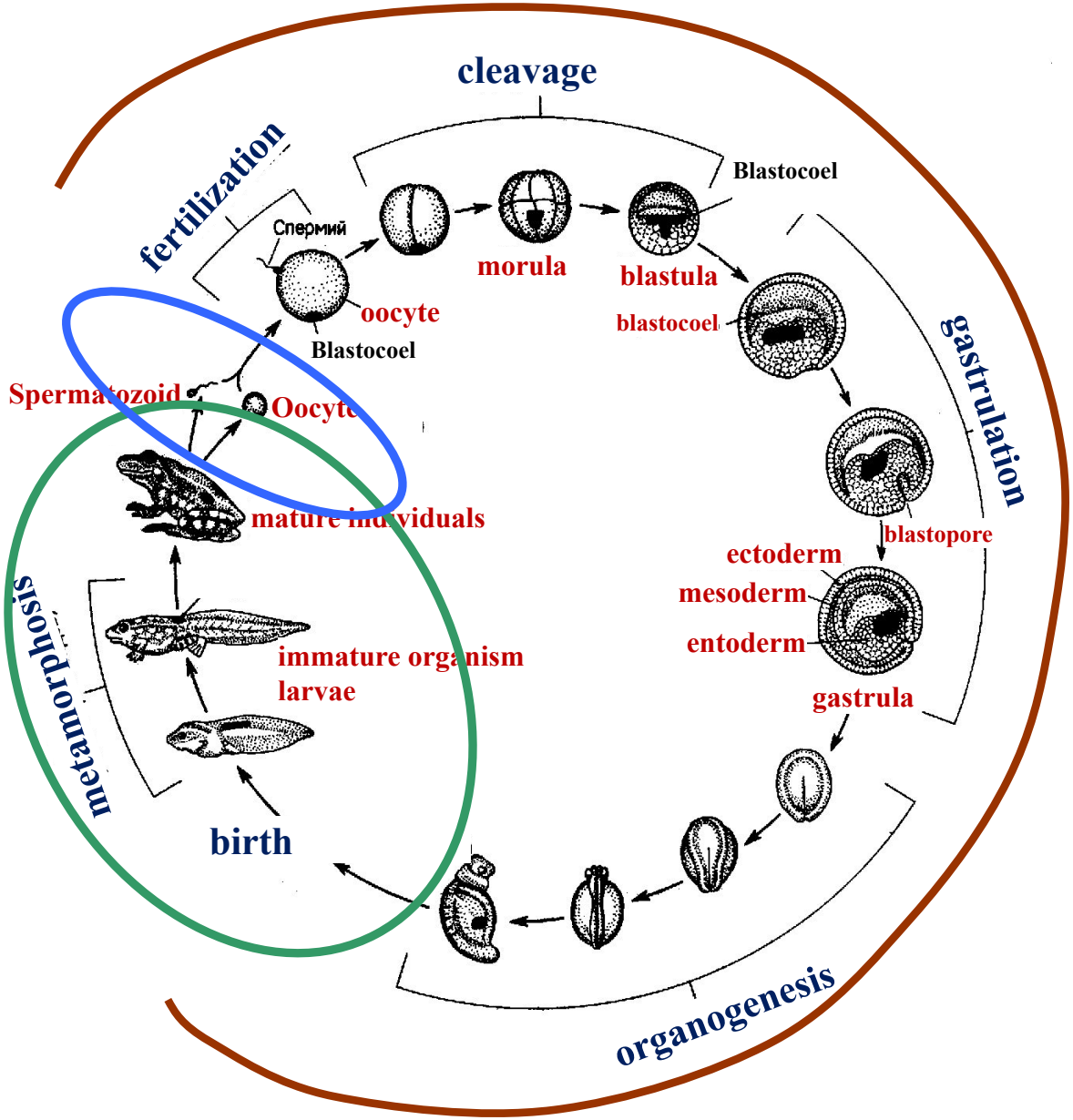
# REGULARITIES OF POST-EMBRYONIC DEVELOPMENT

# PERIODIZATION OF ONTOGENESIS

## Ontogenesis of multicellular organisms is divided into three periods:




1 PREEMBRIONIC PERIOD

2 EMBRYONIC PERIOD (PRENATAL)

3 POST-EMBRYONIC PERIOD (POSTNATAL)

- After the organism has gone out of ovum shells (birth), there begins its postembryonic (postnatal) period of its development. In humans, 5 periods are singled out:
- 1) juvenile period (before puberty),
- 2) puberty (sexual maturing),
- 3) maturity,
- 4) aging,
- 5) death.

- After the pubertal period, there develop definitive body proportions and organ systems come to the mode of functioning inherent to a mature organism.

The postnatal period of ontogenesis is characterized by:

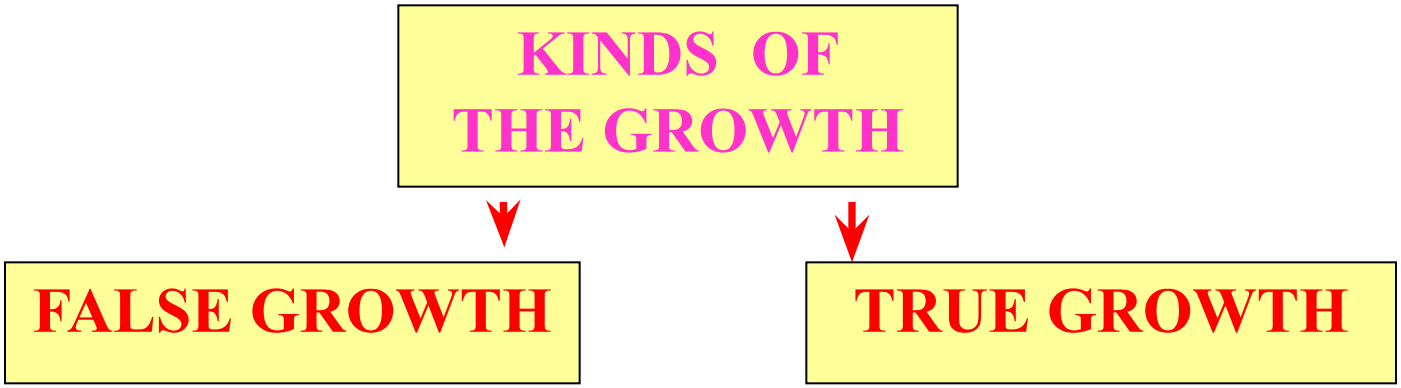
- growth,
- development,
- regeneration,
- aging and maturation
- death.

***Baldung Green Hans.***
**«Three ages of the woman and death»**

# GROWTH

- Usually, under the notion «Growth», one means an increase in the mass and linear dimensions of the species (and its parts). In the basic of the growth, there lie the processes of protein biosynthesis, increase in dimensions and number of cells and non-cellular structures. Howewer, the growth is a universal feature of the living matter characteristic of any level of its organization- from the molecular to the biospheric level.

There exist two main types of growth: false and true




Increasing the size of an organism at the false growth is due to water retention and fat deposition.

**FALSE GROWTH**

*Mechanisms:*

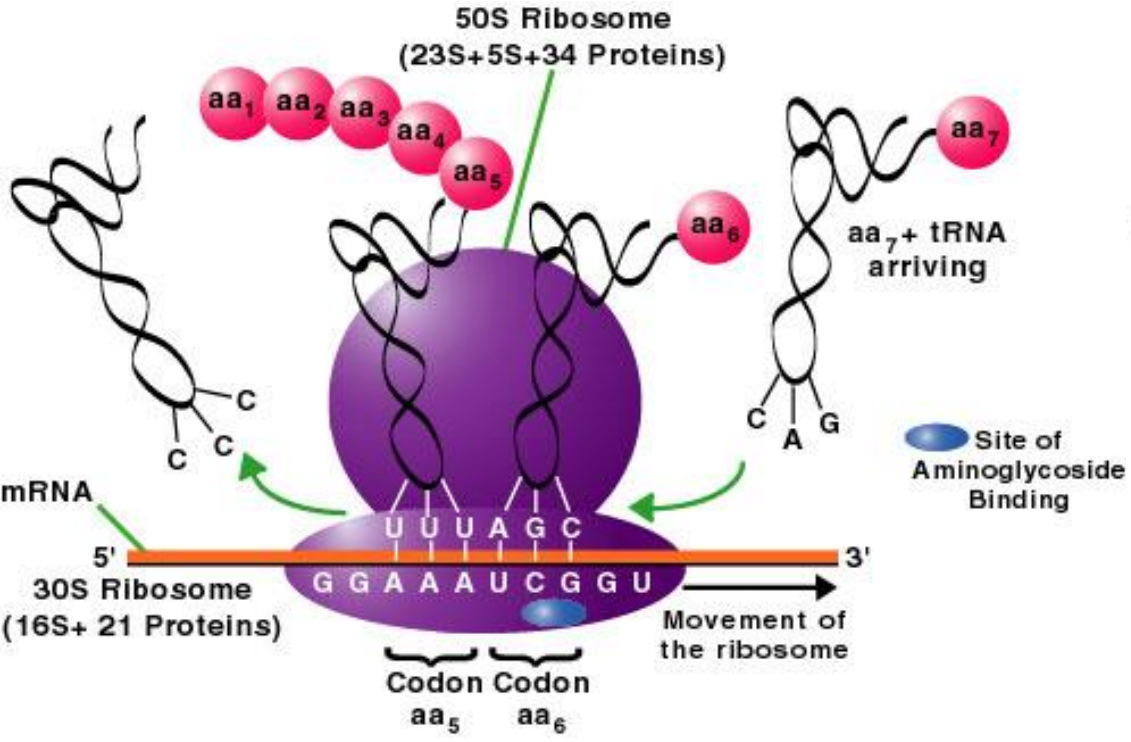
Oedema and flat precipitation (deposit)

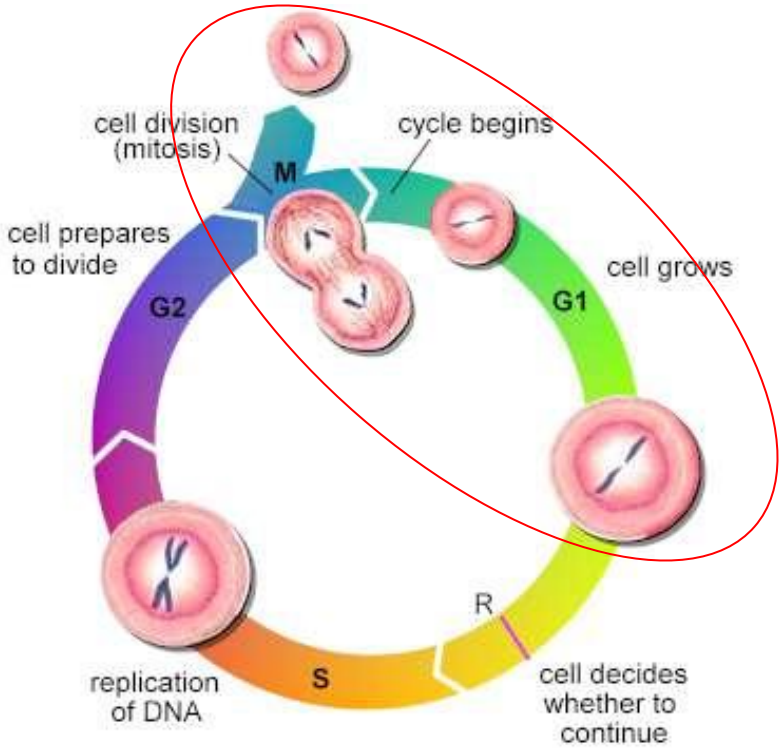
True growth always is provided by a synthesis of the protein, increasing of the quantity and the size of the cells.

**TRUE GROWTH**

*Mechanisms:*

Protein synthesis, division and growth of cells



# True cell growth can be divided into several types:

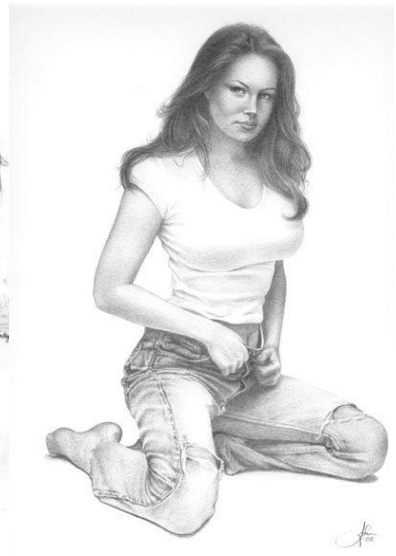
The first classification takes into account the duration of the growth of individuals in its ontogenesis. According to this classification, the growth can be “definite” **(limited)** and “indefinite” **(unlimited)**.

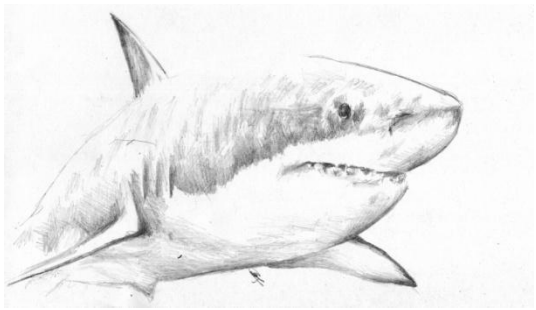
In the case of a “definite growth”, individual grows only during an interval of postembryonic period of their ontogenesis.

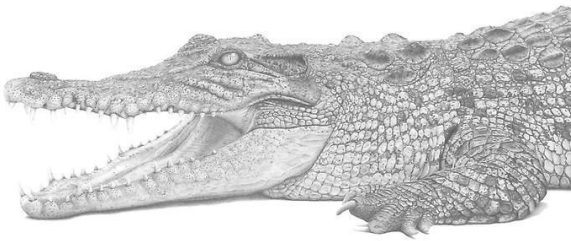
If the organism has an indefinite growth, then the size of the his body is increased whole life.

**TRUE GROWTH**

| | | |
|---|---|---|
| 1 | **Definite (limited)** During an interval (part) of postembryonic period of ontogenesis (mammals, humans) | **Indefinite (unlimited)** During the whole postembryonic period of ontogenesis (fish, crocodiles) |



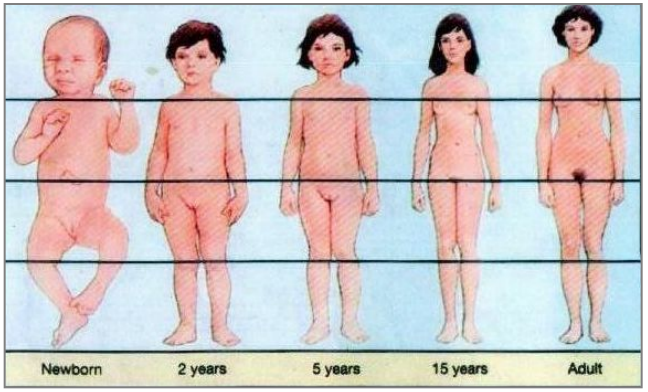


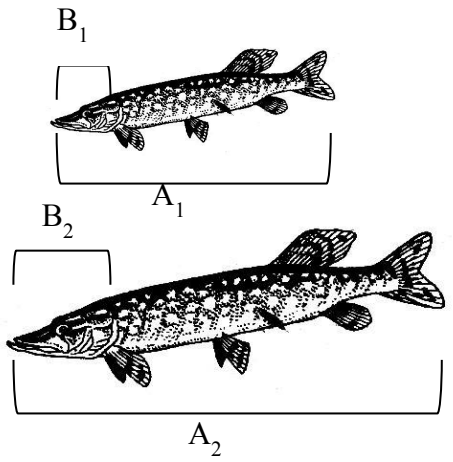


The second classification takes into account the maintenance of body proportions during the life of the individual. According to this classification, the growth can be "**Allometric**" and "**Isometric**".

**TRUE GROWTH**

| 2 | **Allometric** with no preservation of the proportions of body parts (mammals, humans) | **Isometric** with the preservation of the proportions of body parts (fish, crocodiles) |
|---|---|---|




$$\frac{B_1}{A_1} = \frac{B_2}{A_2}$$

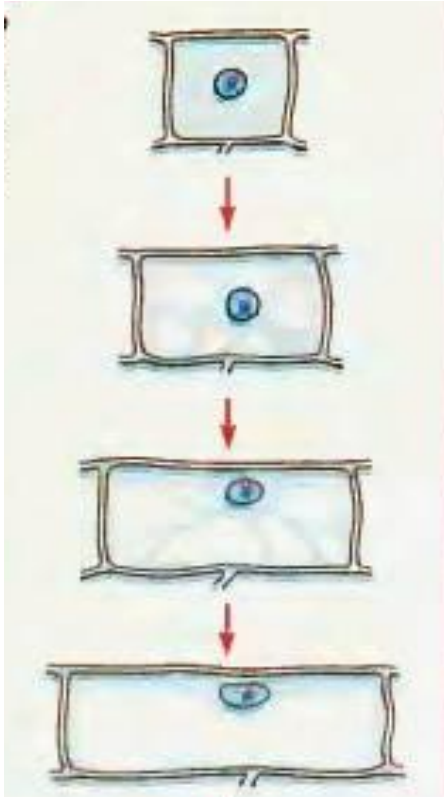
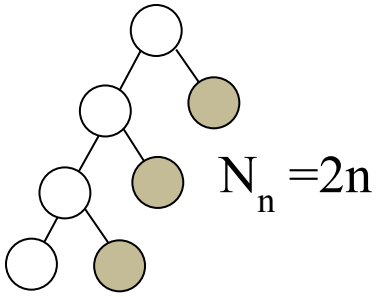
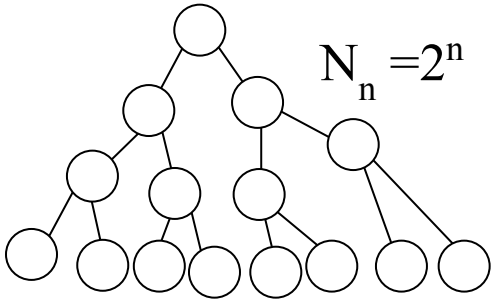
The third classification takes into account the cellular mechanism of growth. According to this classification, the growth can be "**Aucsentical**" or "**Proliferative**".

Aucsentical growth is provided by an increase in cell size.

The basis of proliferative growth is an increase in the number of cells (mitosis).

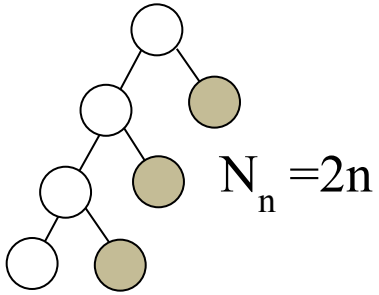
The proliferative growth can be "accrecional" or "multiplicative".

**TRUE GROWTH**

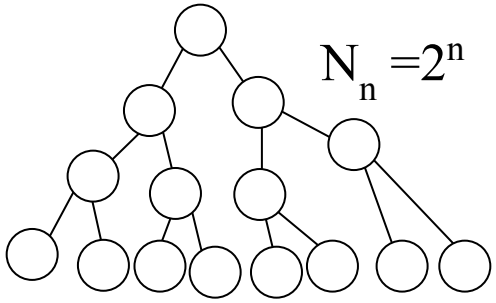
| | **Aucsentical** At the expense of cell growth | **Proliferative** At the expense of cell divisions |
|---|---|---|
| 3 |  | Accrecional   Multiplicative   |

# PROLIFERATIVE GROWTH

Accrecional




Multiplicative



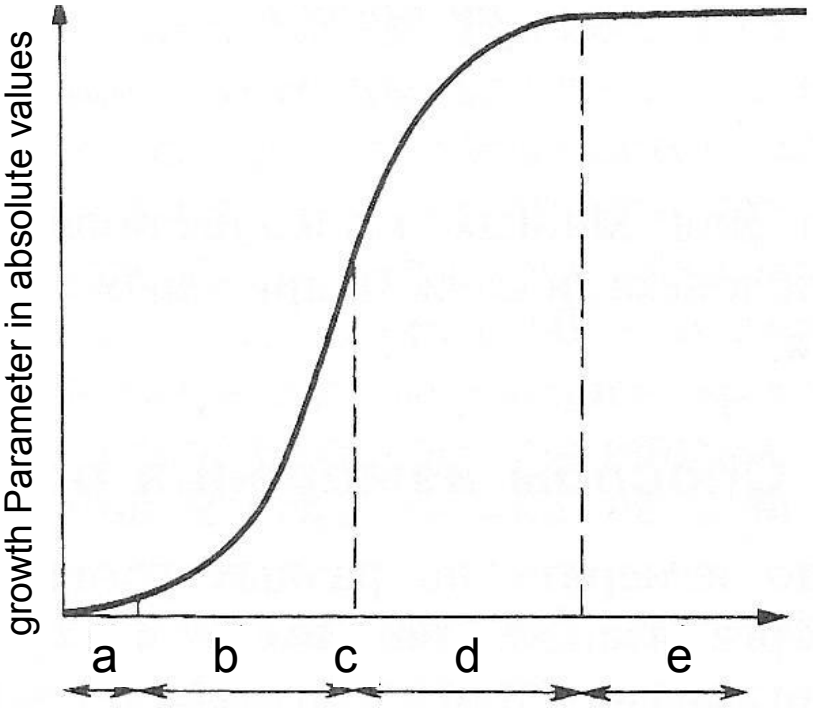

The accrecional growth is typical for tissues, that contain stem cells. After the dividing of the stem cell, one of daughter cells is remained stem cell. In the future this cell can again will enter into mitosis. The other daughter cell is not divided, and differentiate into mature cell type. At this type of growth, the number of cells increases linearly (in the arithmetic progression).

When the multiplicative growth occurs, each daughter cell enters to mitosis again. In this type of growth the amount of cells is increased in a geometric progression.

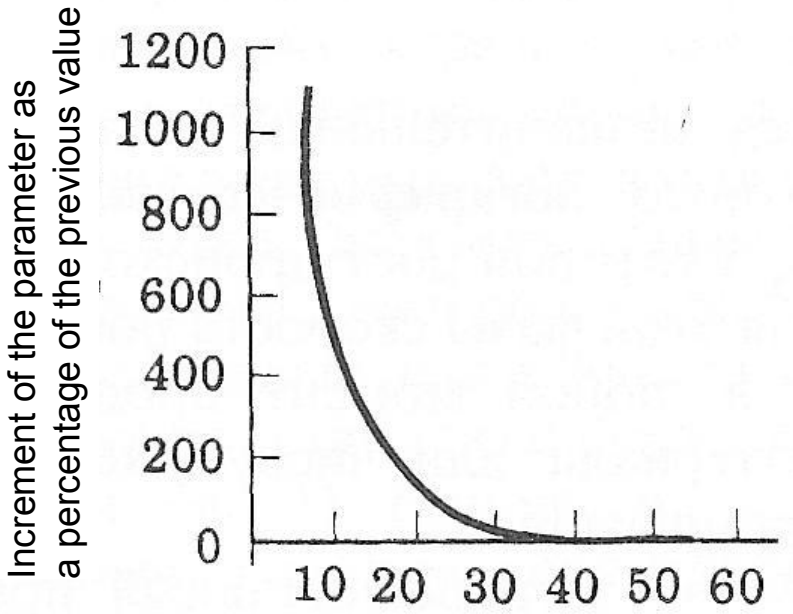
# The growth of any living object or his part may be represented graphically.

There are many ways of creating growth graphs, but two of them are basic. These are graphs of the absolute and relative rate of the growth.

The graphs of the absolute growth



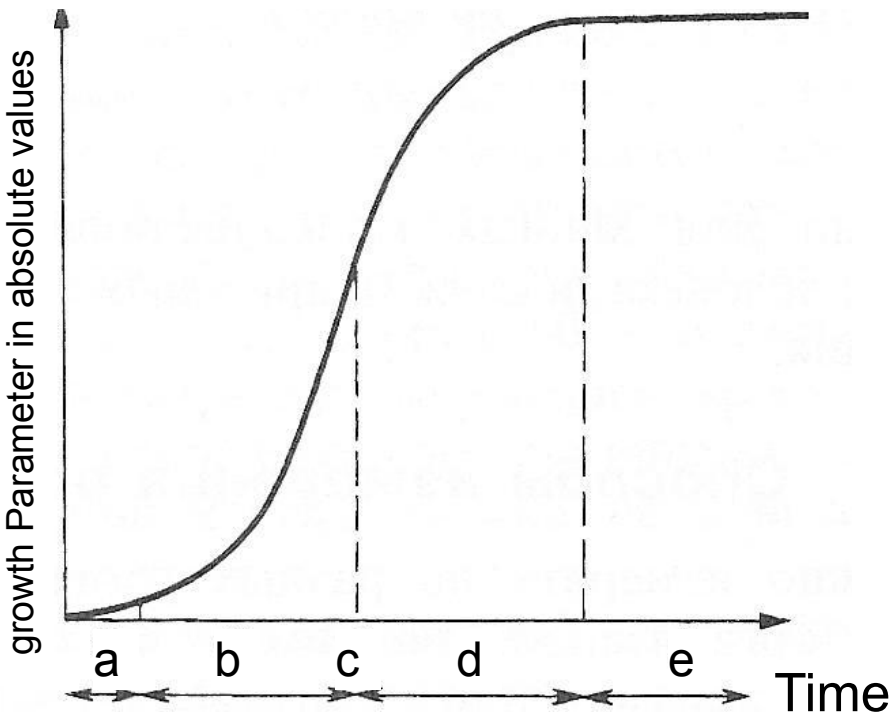

The graphs of the relative rate growth



To plot the graph of the absolute growth we must be noted the time on the abscissa axis (OX) and the value of measured parameter in absolute values (kg, meter, pieces, etc) - on the ordinate axis (OY).

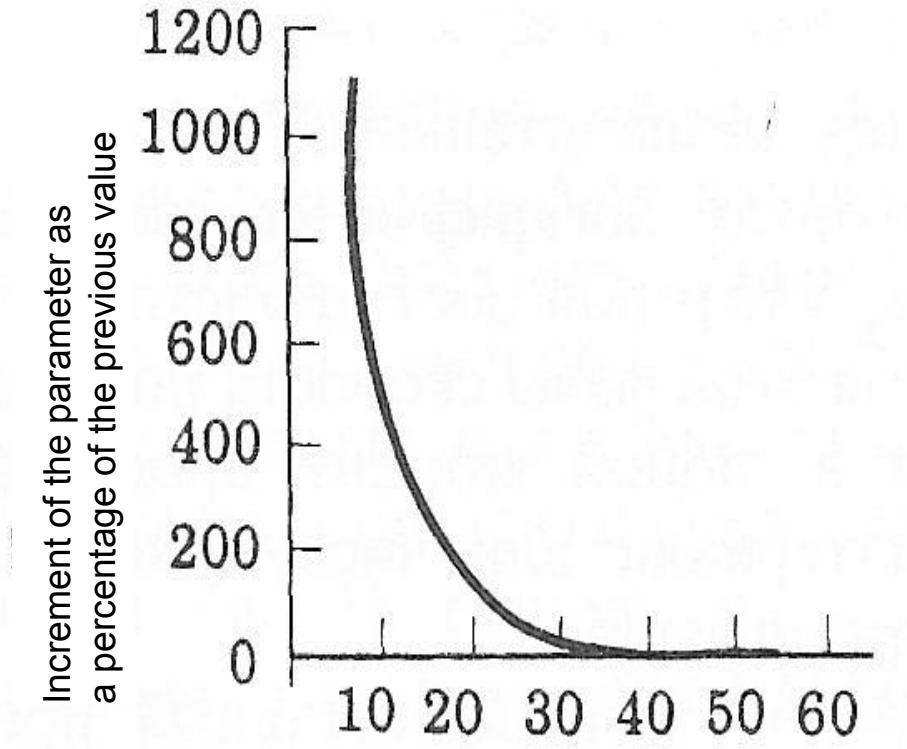
The curve has a characteristic shape. Several segments can be identified in it:

a) in the lag phase, the growth is carried out very slowly
b) in the logarithmic phase, the growth is carried out is very quickly
c) At the point of inflection of the growth begins to slow.
d) The next segment of the curve is called the phase of slowing growth.
e) In conclusion, the registered parameter stops increasing and overlooks on the stationary level. This stage is called phase-plateau.



To plot the graph of relative rate of the growth we must be noted the time on the abscissa axis (OX) and the increase of the parameter studied in percentage of the before measured value - on the ordinate axis (OY).

The curve shows that the highest growth rates always have a place in the beginning of the process. Over time, the rate of growth rate is reduced. At the end of the process the parameter changes are becoming not significant.



# DEVELOPMENT

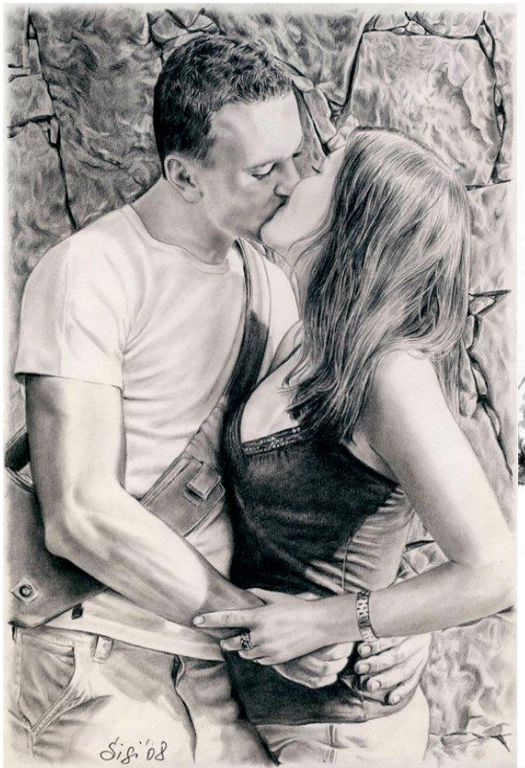
- Under the development, it is accepted to understand a totality of relatively slow progressive changes resulting in the appearance of multicellular organisms. Usually, the species development begins with the fertilization  and comes to an end only at the death.

# The development concerns all organs and systems of the organism.

This is especially true in relation to the central nervous system. During age the intelligence and memory are increased.



In postnatal period of the ontogenesis the reproductive system and the locomotor system are exposed to the considerable changes.



# REGENERATION

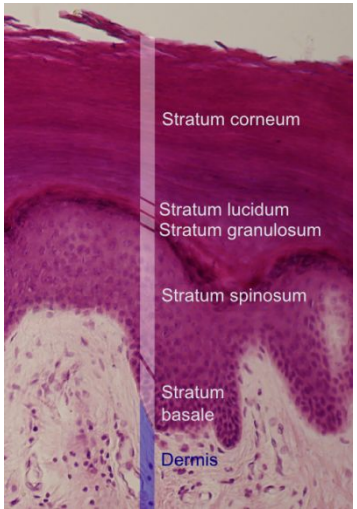
- Regeneration is the restoration of the lost parts of the organism (cells, tissues or organs).

# There are two types of regeneration:

## PHYSIOLOGICAL

The restoration of the structures, the loss of whose is a natural event of ontogenesis, is called the physiological regeneration.

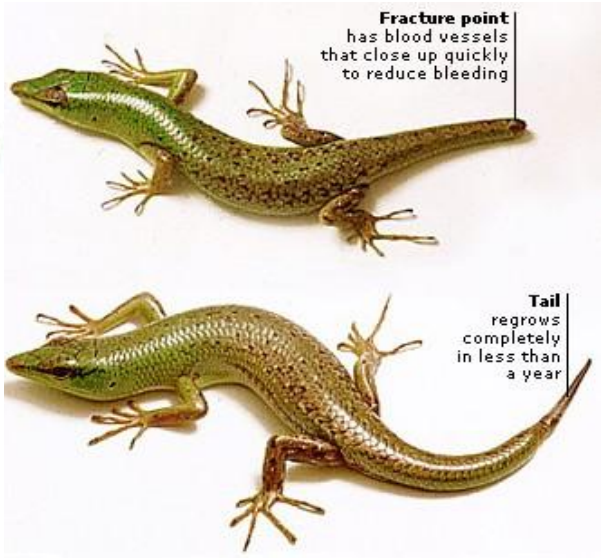
An example of such regeneration is to update the erythrocytes, the epidermis of the skin, intestinal epithelium, and etc.


## REPARATIVE

The restoration of structures which were damaged or lost as a result of the injury or disease is called reparative regeneration.

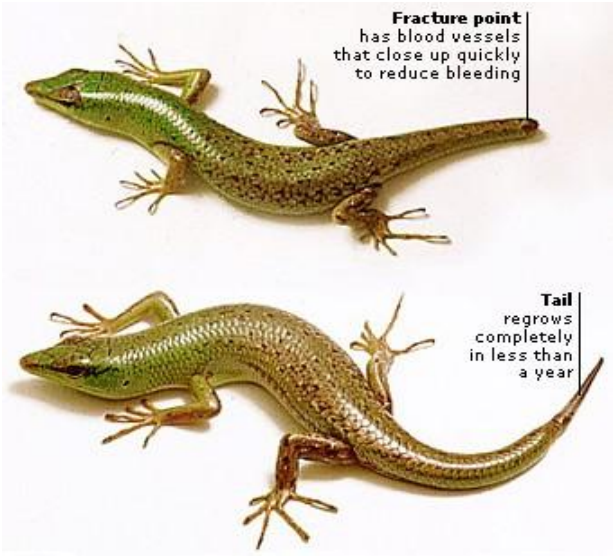
An example of reparative regeneration is the healing of the cuts, the restoring of the lost tail at a lizard, etc.



# BY THE FINAL RESULTS REGENERATION IS SUBDIVIDED INTO:

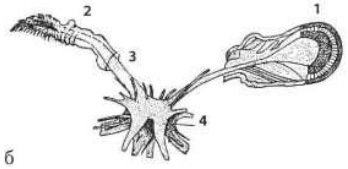
## TYPICAL REGENERATION (HOMOMORPHOSIS)

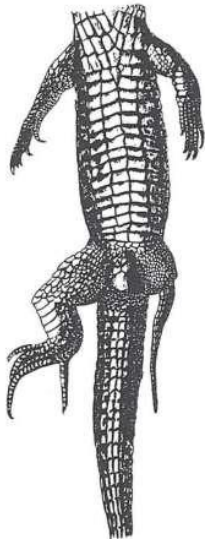
If the regeneration is performed by homomorphosis, then instead of the lost structure is formed exactly the same.

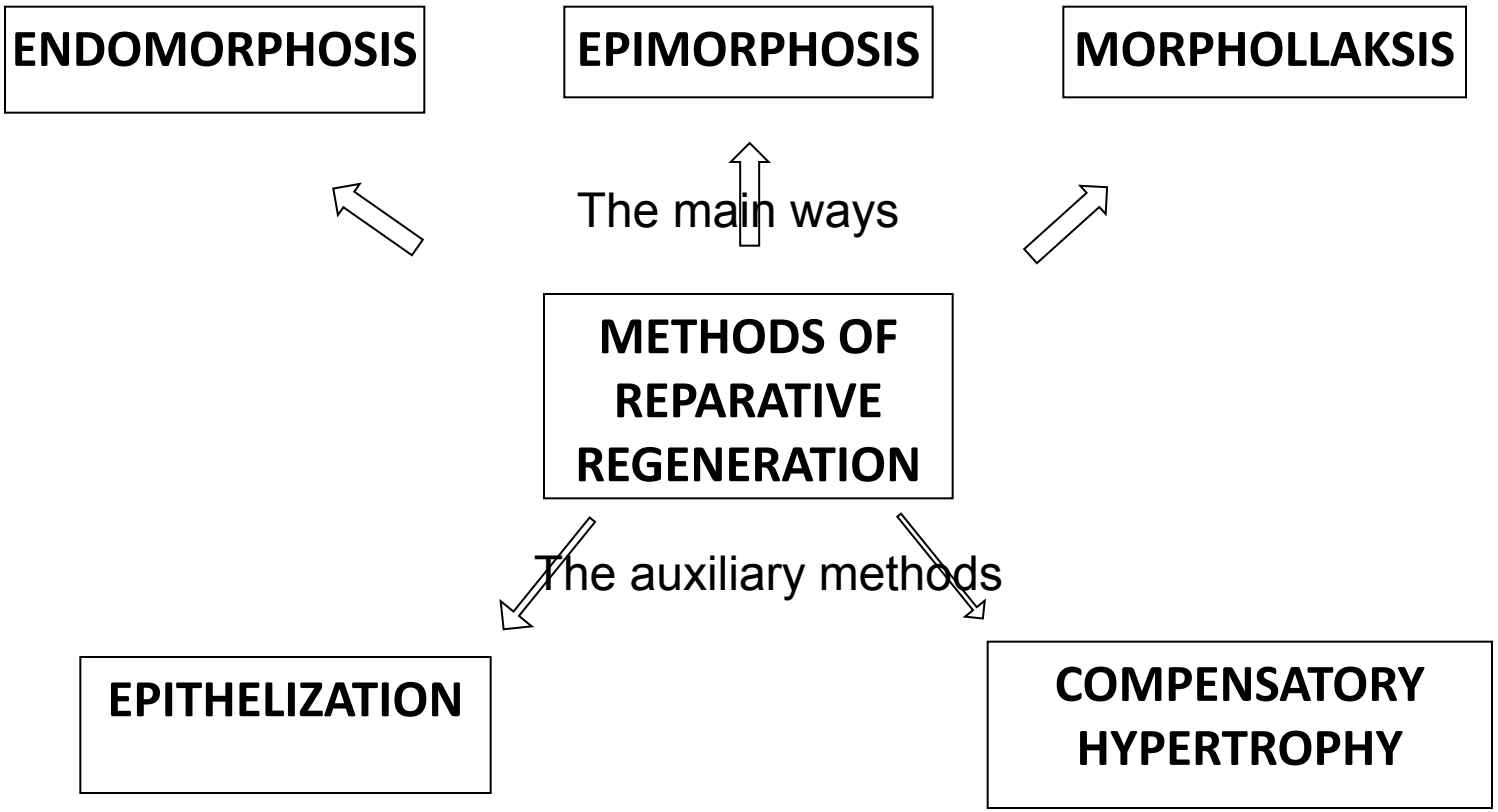



## ATYPICAL (PATOLOGICAL) REGENERATION (HETEROMORPHOSIS)

If the regeneration is performed by heteromorphosis, then instead of the lost structure is formed absolutely another.

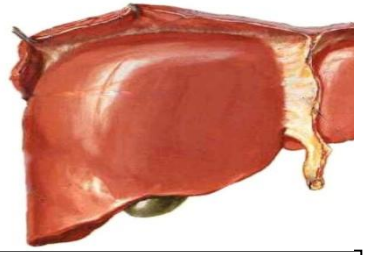



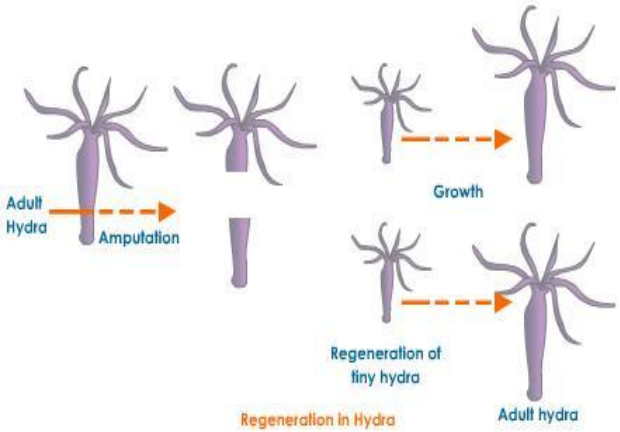



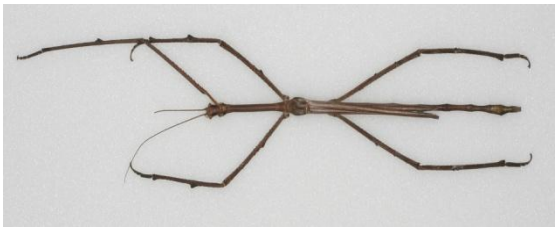

ENDOMORPHOSIS
EPIMORPHOSIS
MORPHOLLAKSIS
The main ways
METHODS OF REPARATIVE REGENERATION
The auxiliary methods
EPITHELIZATION
COMPENSATORY HYPERTROPHY

before the injury

after injury





**ENDOMORPHOSIS**

In this method of regenerating the size, but not the shape of the lost organ is restored.

(*for example: human liver after its partial removal*)

**EPIMORPHOSIS**

In this method of regenerating both the size and shape of the lost organ is restored.

(*for example: the tail of a lizard or body of Hydra* )

**MORPHOLLAKSIS**

In this method of regenerating the shape, but not the size of the lost organ is restored.

(*for example: insect limb*)

The main ways

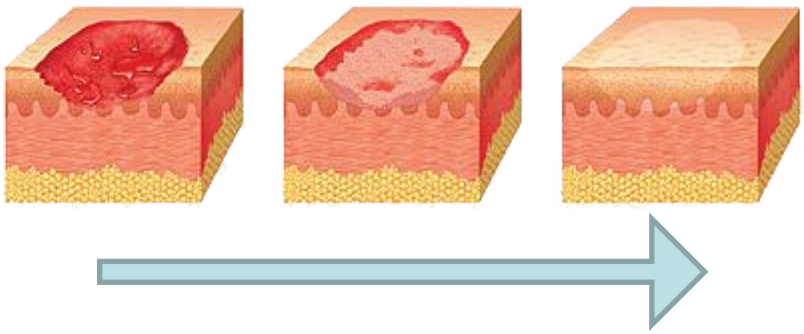
**METHODS OF REPARATIVE REGENERATION**

# METHODS OF REPARATIVE REGENERATION

The auxiliary methods

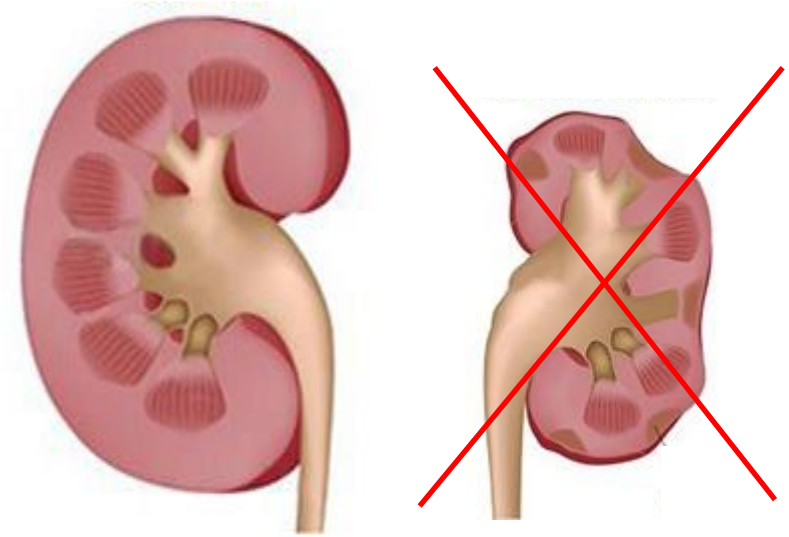
## EPITHELIZATION

The healing of the wounds with a damaged epithelium.
(*for example cuts of the skin*)



## COMPENSATORY HYPERTROPHY

The hypertrophy of the organ after the damage other organ this system.
(*for example increase in size and increased function of the second kidney, after removal of the first one*).



# AGING

- Aging is a regularity process of age-decaying changes of the organism resulting in a decrease in the organism adaptation ability and in an increase in the probability of the death.
- Herontology (from Greek «herontos» - «an oldman», and «logos»- «science») is the science of the old age and aging. It studies the processes of aging from the biological point of view and investigates the essence of the old age, as well as the influence of aging on both the individual and society.

# THE OLD AGE HAS INTERNAL SIGNS

ON THE MOLECULAR LEVEL: changes in nucleotide sequence in DNA (mutations); disorders in transcription and translation mechanisms; disorders in transportional processes, transport and energy consumption, increase in lipid peroxidation and a decrease in the activity of anti-oxidant systems.

ON THE CELLULAR LEVEL: degradation and death of parts of cells, a decrease in cell mitotic activities, a decrease in the number of mitochondria and the decay of lysosomes, changes in plasmolemme properties hyaloplasm dehydration, concentration of decay products (for example, lipophuscine).

ON THE LEVEL OF TISSUE: a decrease in functional activity, a decrease in the regeneration ability, changes in properties of intercellular substance, expanding growth in the organs of connective tissue.

ON ORGAN AND ORGANISMAL LEVEL: sclerotization of vessels, a decrease in the blood supply of organs and tissues, a decrease in life-volume of lungs, loss of teeth, a decrease in the secretion of digestive glands and motoric of organs of stomachic-intestinal duct, a decrease in filtration efficiency, reabsorption and secretions in nephrons, death of parts of nephrons, atrophy, and a decrease in the strength of skeletal muscle contractions, osteoporosis in the old age, a decrease in spermatogenesis efficiency, termination oogenesis, a decrease in hormonal sexual gland functions, a decrease in the efficiency of nervous and humoral organ regulations, a decrease in the efficiency of organs of sense, and immune system

# THE OLD AGE HAS EXTERNAL SIGNS

Changes in bearing (carriage) and gait; decrease in mobility, changes in the voice tembre, skin wrinkles; decrease of memory characteristic changes in behavior, way of life, place and position in society.

# DEATH

- Death is the termination of the organism life activity, the extinction of the organism as an isolated living system.

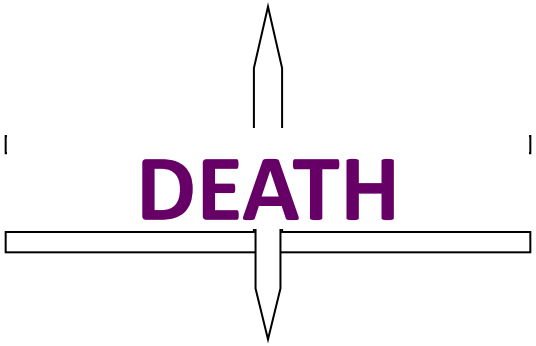
- The science that studies kinds and mechanisms of the death is called «*tanatology*».

**PHYSIOLOGICAL**

It comes due to natural aging processes.

**PREMATURE**

Caused by illnesses and diseases, damages of organs important for life.




**CLINICAL**

Reversible state. Reanimation is possible in the absence of damages of life-important organs.

**BIOLOGICAL**

Irreversible state. Reanimation is not possible even in the absence of damages in life-important organs.

# *SIGNS AND CHARACTERISTICS OF CLINICAL DEATH*

- *Absense of heart-beating,*
- *Absence of respiration,*
- *Absense couscionsness,*
- *Absense of the pupil reflex.*

- Duration: 6-7 minutes. The cortex of large hemispheres, sub-cortex structure and marrow stem do not function, but retain (preserve) a life ability. Cells of all organs and tissues remain alive in a human being.

# *SIGNS AND CHARACTERISTICS OF BIOLOGICAL DEATH*

- *Preservation (retention) of a changed form of the pupil at constraining the pupil of an eye,*
- *Appearance of putrid (cadaverous) spots,*
- *Sings of tissue decomposition.*

- It comes after the clinical death. The Harward criterion-death of cerebral marrow (including marrow stem) with the disappearance of all the stem reflexes. It is characterized by a certain sequence (not simultaneons of the death of all tissue cells and organs of a human being.