LECTURE 6

THEME: The morphology and anatomy of leaf.

The concept of photosynthesis.

Plant respiration.

Plant nutrition.

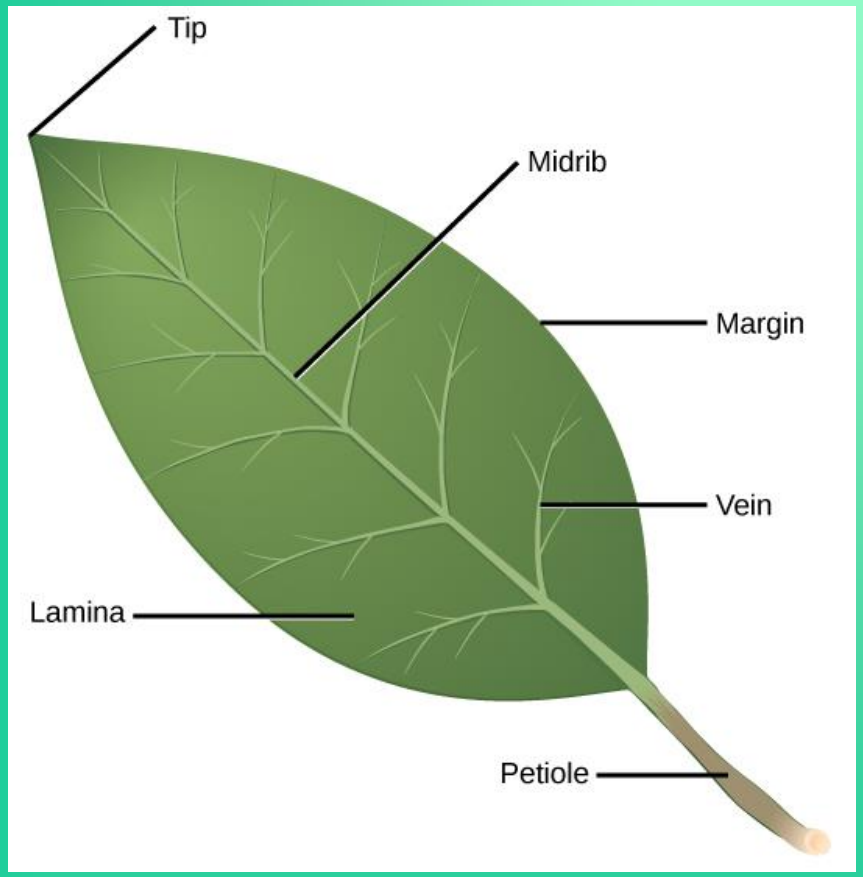
Growth and development of plants.

Leaf (Folium)

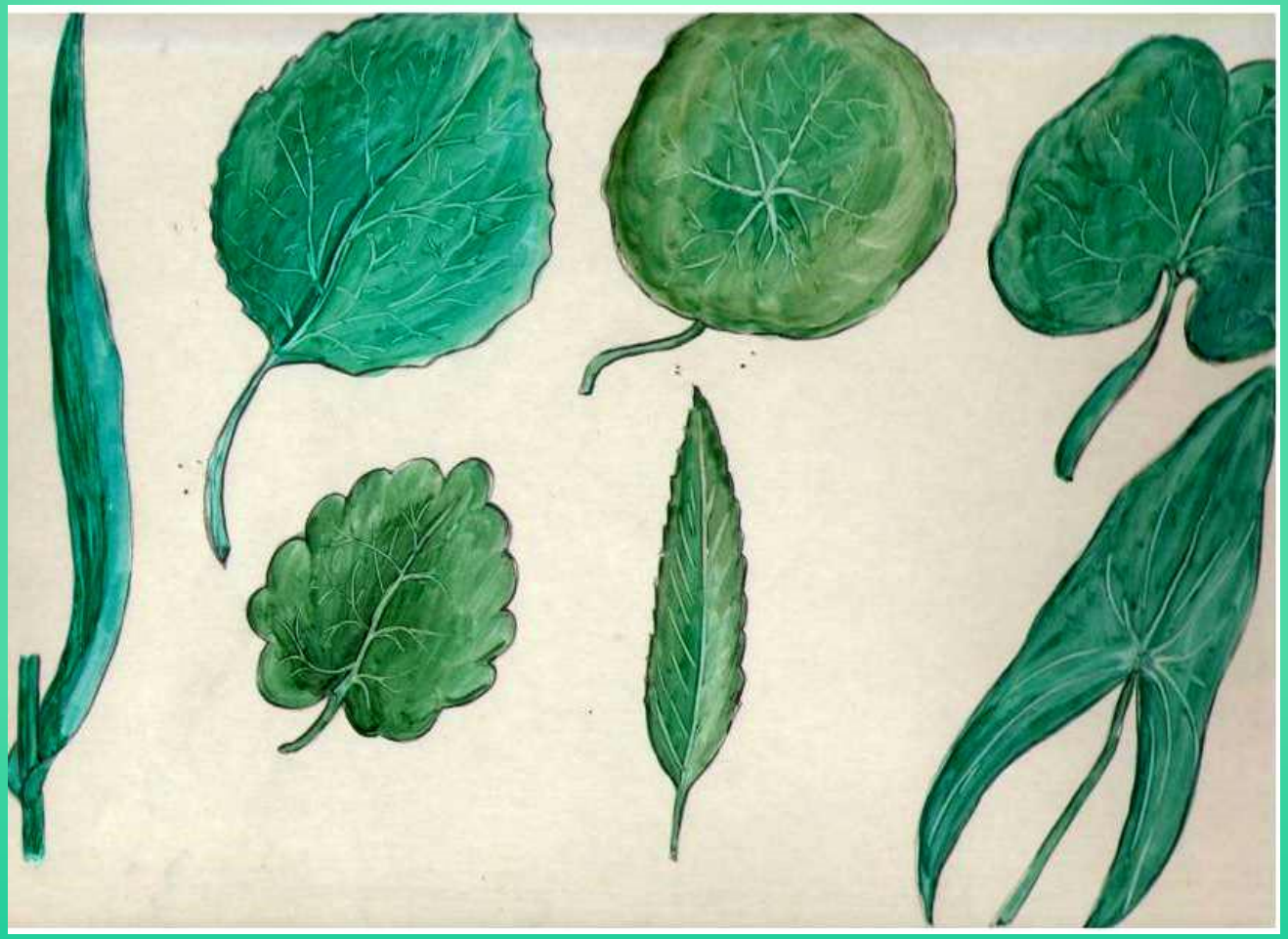
The most important organ of the plant is a leaf. In this organ there are three vital processes - photosynthesis, gas exchange, transpiration. Of these, the process of photosynthesis is particularly attracting attention. In the process of photosynthesis, inorganic substances, obtained by leaves from soil and air, are converted into organic, using the energy obtained from sunlight. Another important function of the leaf, as noted, is the evaporation of water, i. e. the phenomenon of transpiration and, in general, the balancing of gas exchange. The external and internal structure of the leaf fully corresponds to the performance of these functions.

Despite the fact that leaves of different plants differ from each other in structure, they have common parts. In most cases, three parts of the leaf are identified. The most important of these is the leaf blade (lamina). Usually the leaf blade is flat, wide, whole or indented in various forms. The lamina is attached to the shoot by means of a petiole. The petiole is the second part of the leaf. It moves the leaf blade in the direction of the sun's rays. A leaf without a petiole is called sessile. The third part of the list is the stipules. Stipules consist of a pair of small, in rare cases, large leaflets. In many plants, such as oak, beech, chestnut, etc., stipules fall off as soon begins to grow lamina.

Structureof the leaf

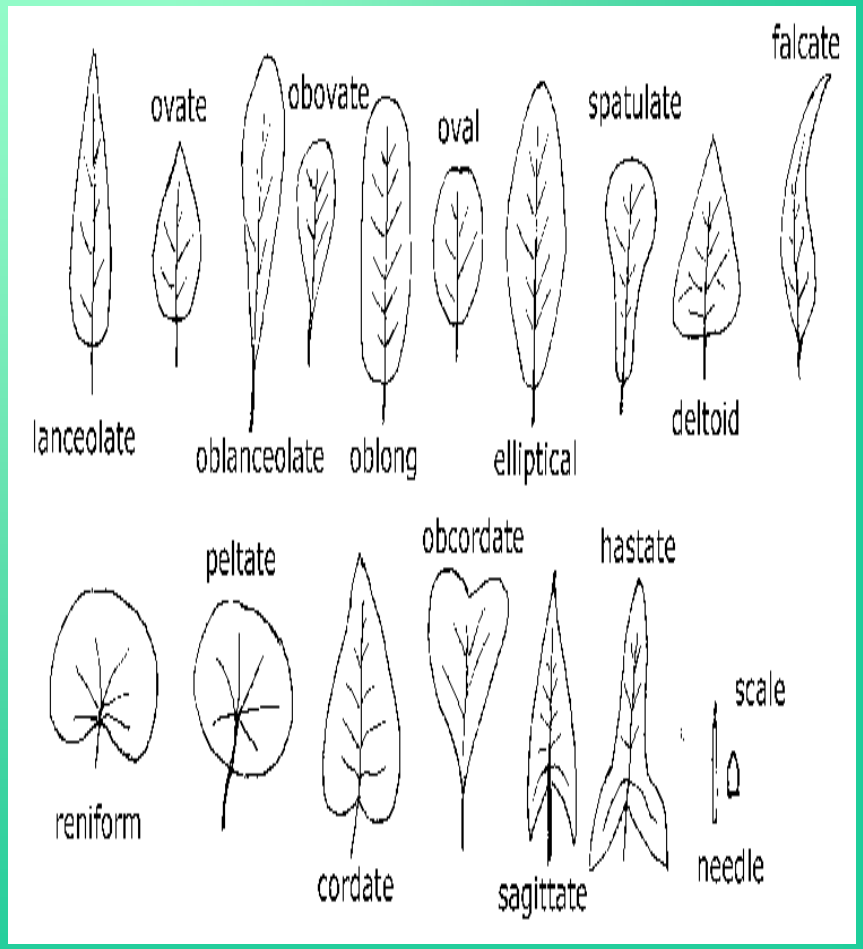


Simple leaves



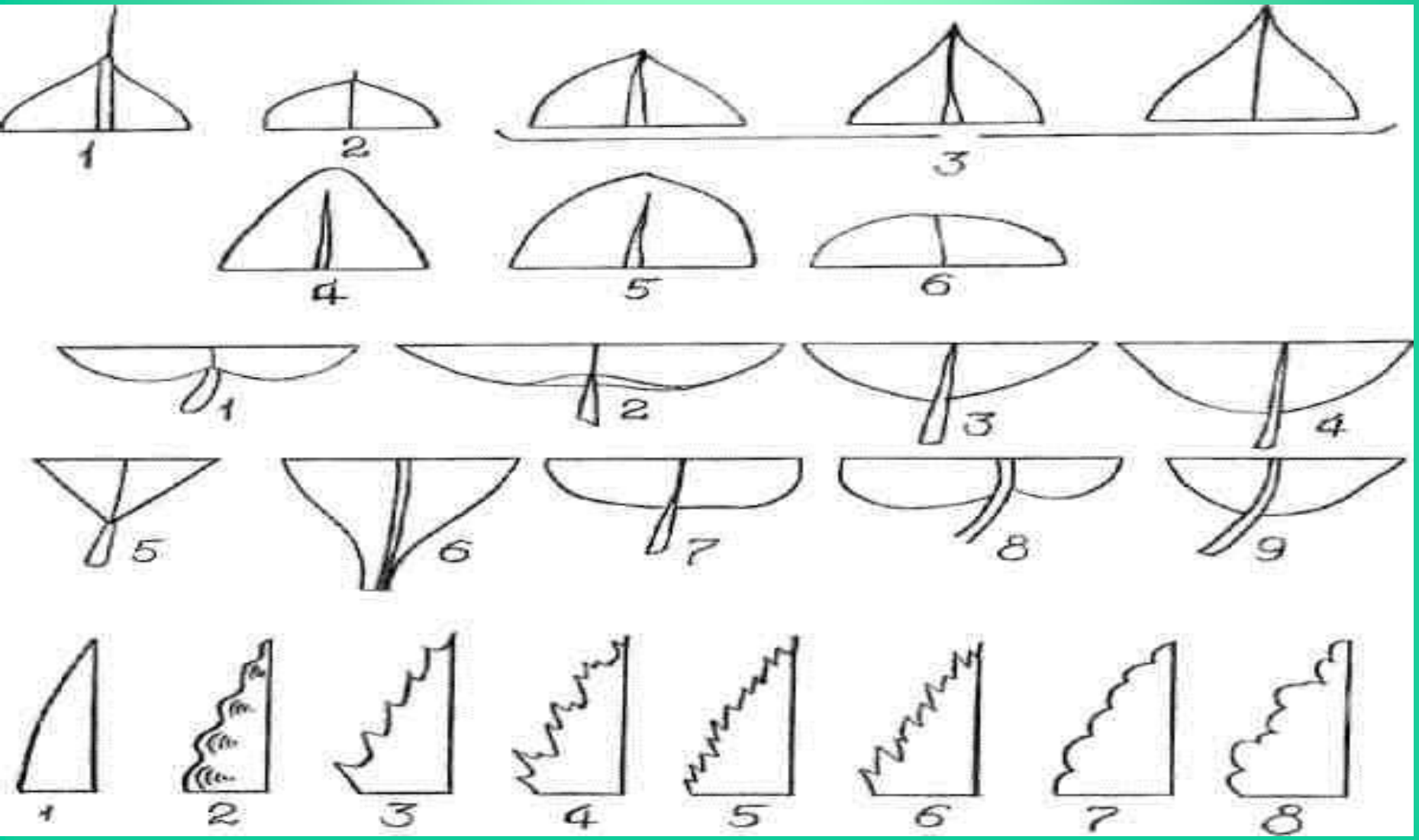
Shape of leaf blade of simple leaves

- Simple leaves are those leaves, in which only one leaf blade is attached to one petiole, and when the leaf falls, the leaf blade falls off along with the petiole. Simple leaves can be grouped, according to the shape of the lamina in the following way: rounded, oval, elongated, linear, ovate, lanceolate, obovate, oblanceolate, sagittate, spear-shaped, diamond-shaped, elliptical, cordate, kidney-shaped etc.



Forms of leaf apex, base and margins.

A – leaf apex: 1-attenuate, 2-acuminate, 3-acute, 4 - obtuse, 5-rounded, 6-mucronate; B – leaf base: 1-cordate, 2-kidney-shaped, 3-rounded, 4-round-wedge shaped, 5-wedge-shaped, 6-descending, 7-emarginate, 8-un-equal sided, 9-oval; C – leaf margins: 1-entire, 2-wavy, 3-serrate, 4-doubly serrate, 5-dentate, 6-doubly dentate, 7- crenate, 8-doubly crenate



COMPOUND LEAF

- Compound is leaf, in which the leaf blade consists of several leaves, and when falling, first the leaf fall down, and then the petiole. Compound leaves, basically, are of three types:
- Palmately compound leaf,
- Pinnately compound leaf
- Tricompound leaf.
- Pinnately compound leaves are, in turn, divided into two groups:
- Odd-walnut, rose, white acacia
- Even - Peas, vetch, yellow acacia
- Odd pinnately compound leaves on the end have one leaflet. Even pinnately compound leaves at the end have a pair of leaves.

LEAF ANATOMY

Anatomy of the leaf corresponds to its functions. Thus, its main mass consists of an assimilative tissue of parenchymal type, rich in chlorophyll.

1 - upper epidermis:

2 - palisade mesophyll cells

3 - spongy mesophyll cells

4 - air space

5 -6 bundle sheath cell and vascular bundle:

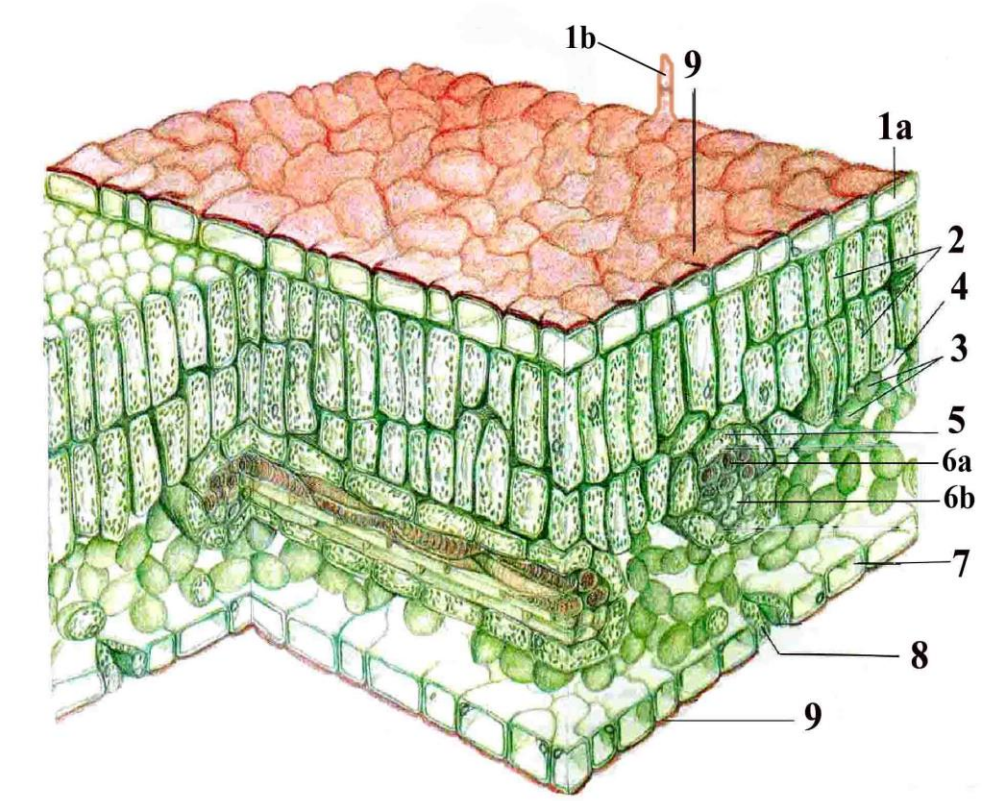
a - xylem;

b - phloem

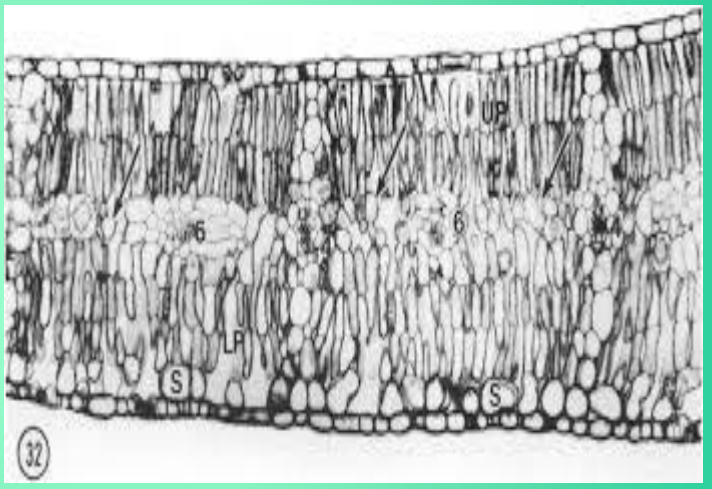
7 - lower epidermis

8 - stoma

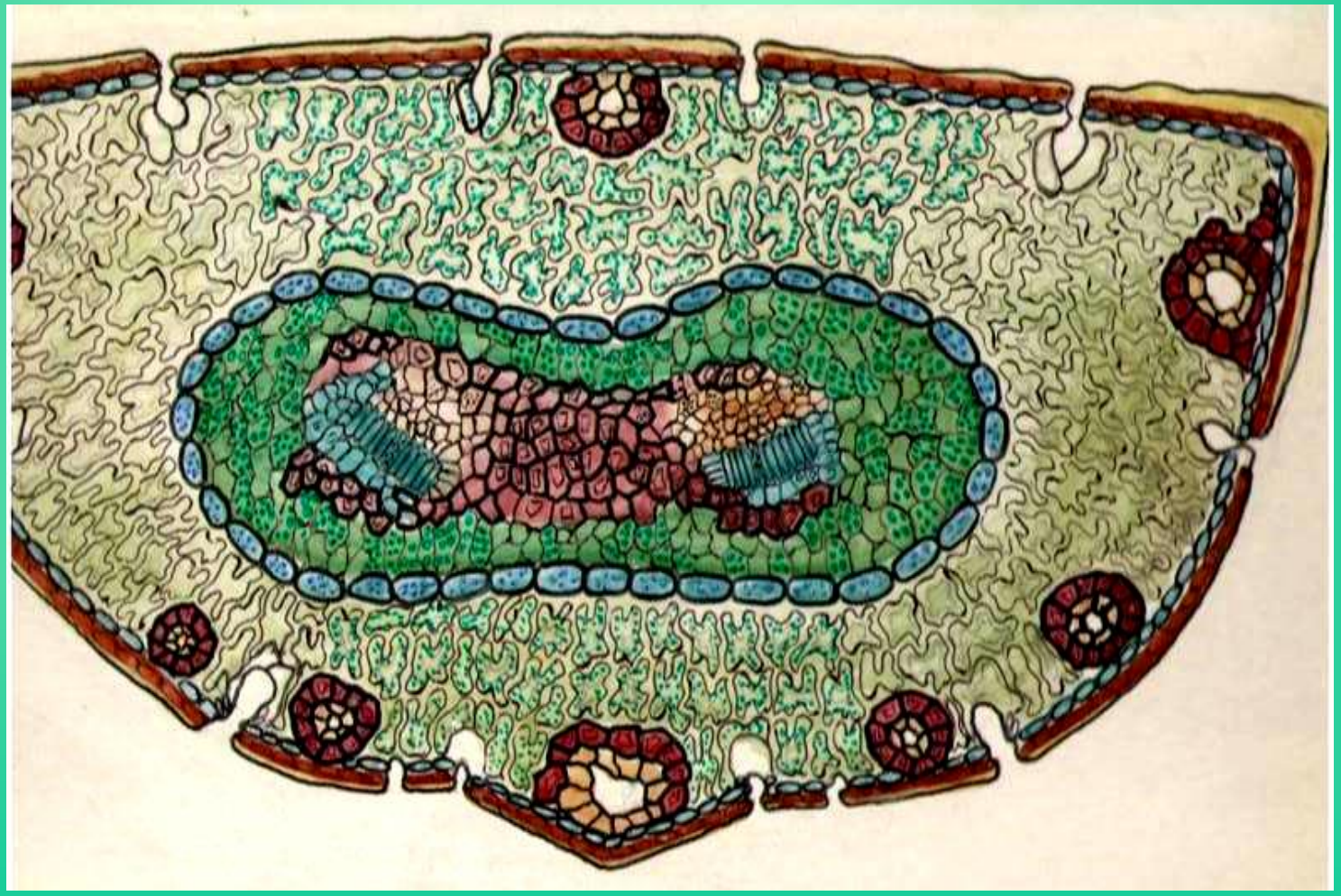
9- cuticle



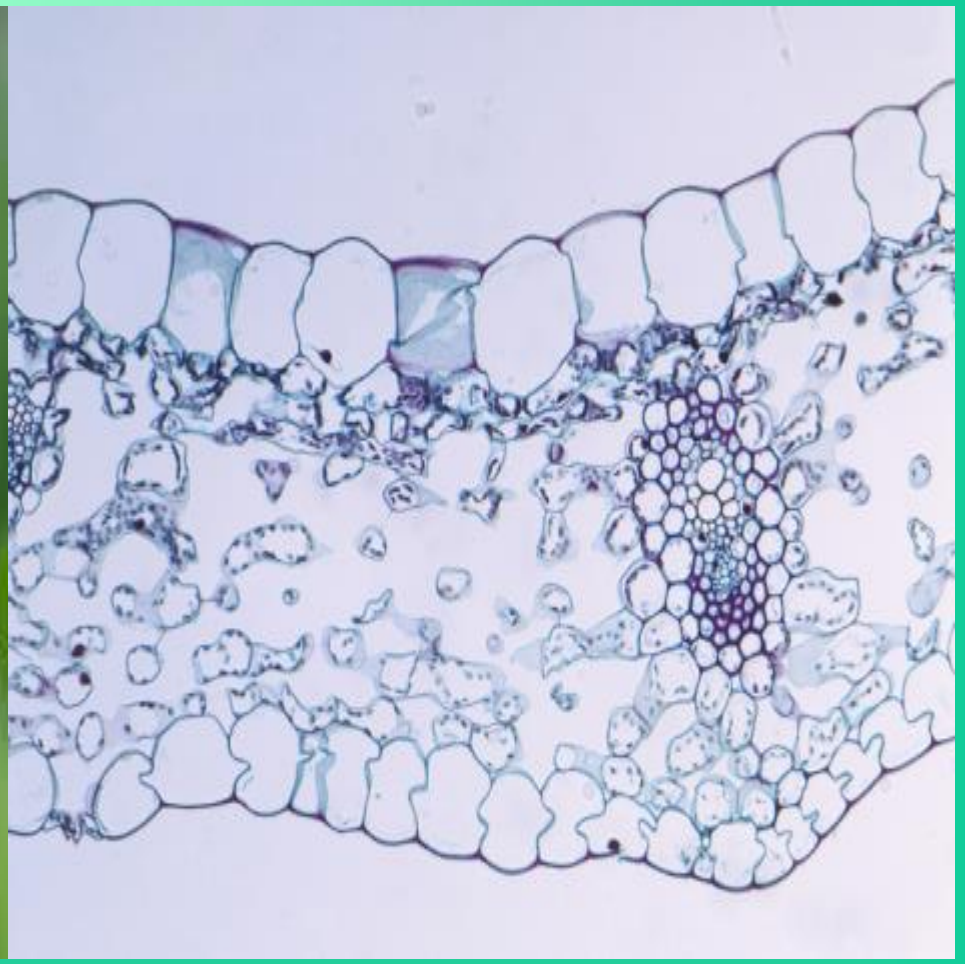
- The **palisade tissues** consist of elongated cells. They are present at right angle to the epidermis surface. The palisade may consist of more than one layer of cells. There are comparatively shorter Cells in the lower palisade layer. The palisade is more specialized photosynthetic tissues. These cells have more chloroplasts than the cells of the spongy tissues. The leaves are divided into three types on the basis of arrangement of palisade:
- **Bifacial leaf:** In flattened leaves, the palisade layer is restricted to the upper side. Such leaves are called bifacial or dorsiventral.
- **Isolateral leaves**: lithe palisade is present on both sides of the spongy tissue, then the leaf is called isolateral.
- **Centric leaves:** The palisade Forms a continuous ring around the spongy tissue in narrow and cylindrical leaves. Such leaves are called centric leaves
- 2. **Spongy parenchyma:** The spongy‘ parenchymas are present at lower side. They are almost isodiametric cells. They have abundant air spaces. The presence of a large number of intercellular spaces allo‘%s the free exchange of gases. These spaces also increase the internal surface area.



Anatomy of **pine-tree leaves**



The anatomical structure of the lily of the valley leaf (“lying parenchyma")



The main physiological processes, taking place in plants

Photosynthesis

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Respiration

$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O$.

(The rate of photosynthesis is 10-30 times higher than the rate of the respiration process)

Fermentation

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Transpiration - evaporation of water

- Photosynthesis is a complex chemical process that takes place under the influence of sun rays with the participation of chlorophyll grains, as a result of which a primary product of glucose is synthesized in a plant from CO2 and water.
- (In plants, parallel to photosynthesis, there is a reverse process – respiration.) Just like in other living organisms, breathing in plants is accomplished by consuming oxygen, disintegrating organic substances, and releasing CO2 from the organism. It was accepted to express the breathing process by a simple equation:
- Some bacteria and fungi (yeast fungi) receive the energy, necessary for life activity, in the process of fermentation.
- In the organism of the plant occurs the evaporation of water, which is called transpiration.

PLANT NUTRITION BY ROOT AND AIR

- Plants feed, receiving the necessary elements, from two environments: earth and air. Thanks to photosynthesis, plants, primarily, obtain C and O2 from air in the composition of CO2. Assimilated essential organic substances appear in the leaf. One part of the elements, needed by the plant organism, comes from the soil through the roots. Thus, in a plant 2 groups of substances of different origin are concentrated at 2 poles and a problem arises in transferring them in two directions.
- Nutrition through the roots is called mineral nutrition, during which from the soil are absorbed, transferred and digested the biogenic elements from the nutrients, necessary for the organism of the plant. The presence of the following elements in the mineral nutrition of plants is very important. Some of them (8) N, S, Mg, K, Ca, P, Na, Fl are required in large quantities and called macroelements. Te, Cu, B, Ma, Co, Zn, Mo are required in small quantities and called microelements.
- Microelements, being components of enzymes, regulate their activity.
- Mineral nutrition of plants, especially nitrogen nutrition, is, to some extent, associated with the processes of plant growth and development. Most nutrients enter the overground organs with the help of the root in the form of ions of mineral salts, their aqueous solutions.
- Multicellular organisms and aquatic plants absorb mineral nutrients throughout entire surface of the body. Absorption through the roots is a very complex mechanism. After diffusion into the root, the nutrients travel to other organs.

Growth and development of plants

- Growth is an increase in the body weight of plants. Growth occurs as a result of the division and growth of meristematic cells.
- A distinctive feature of organisms of highly organized plants is that they grow at the expense of meristem cells throughout life. There are three phases of growth: the first phase - embryonic growth - is characterized by the multiplication of cells, which occurs in the cone of growth and cambium of the root and stem (bud). The 2nd phase is determined by the stretching (elongation) of the cells. Stretching (elongation) of cells is the reason of increase of their (meristemic cells) volume by hundreds of times. The third phase is accompanied by the differentiation of cells and is associated with the previous 2 phases.

ONTOGENETIC DEVELOPMENT

The history of individual development is called ontogenesis.

Ontogenesis reflects the whole life, from the moment of the birth of an individual to the moment of death, and the morphological, anatomical, biological, biochemical, and physiological changes that took place in it.

Growth. Growth is an indicator of quantity.

Growth is the process of the formation of new elements in the structure of the plant to increase the volume, weight and other quantitative indicators.

DEVELOPMENT

- There are 2 types of development in plants:
- 1. individual development of the organism or ontogenesis.
- 2. historical development of the plant species or phylogenesis. Ontogeny is the period of any plant organism from the moment of the onset of the development of a fertilized egg to natural death. Phylogeny is the path of development of a species or group of plants.

RELATIONSHIP OF GROWTH AND DEVELOPMENT

The growth and development of the organism during its life can be in the following states:

1. Rapid growth, rapid development.
2. Weak growth, weak development.
3. Rapid growth, weak development.
4. Weak growth, rapid development.

REPRODUCTION OF PLANTS

Reproduction is one of the important properties of a living organism. The ability to reproduce is inherent not only to organisms of a higher and complex structure. Even viruses that do not reach the level of cell structure in their development, increase their generations, recreating new living organisms like themselves by reproduction.

In different groups of the plant world, various ways of reproduction are common. In all plants, starting with the simplest and ending with the higher ones, including the flowering ones, the observed methods of reproduction can be divided into three groups: vegetative reproduction, asexual reproduction and sexual reproduction.

VEGETATIVE REPRODUCTION

In vegetative reproduction, a new organism arises from a part of the maternal organism.

The higher plants, and especially the flowering, have quite diverse methods of vegetative reproduction. They were expanded in cultural conditions and improved in a beneficial way by people. Both in wild and in cultural conditions, flowering plants multiply by all three vegetative organs (root, stem, leaf) and their metamorphosed forms.

ASEXUAL REPRODUCTION

In the plant world, asexual reproduction occurs by means of spores and zoospores. They are single cells, adapted for reproduction. Spores and zoospores, without fusion with other cells, i.e. without fertilizing, grow and give rise to a new plant organism. The development of spores and zoospores takes place on the mother plant in special spore-forming cells or organs. Places of formation of spores are called *sporangia*, and zoospores are called *zoosporangia*.

SEXUAL REPRODUCTION

During sexual reproduction, a new organism is formed as a result of the fusion of two cells, differing in their physiological properties (implying sex distinction), i.e. as a result of fertilization. In sexual reproduction, in fact, multiplication in the literal sense does not occur, on the contrary, two haploid cells unite and form one diploid cell, this diploid cell gives rise to a new organism, and it is called sexual reproduction. Sex cells are called gametes. Gametes have two forms: the male gamete and the female gamete. A diploid cell, formed as a result of fertilization from the fusion of two gametes, is called a zygote. The word zygote is taken from the Greek zygone, i.e. fusiom.

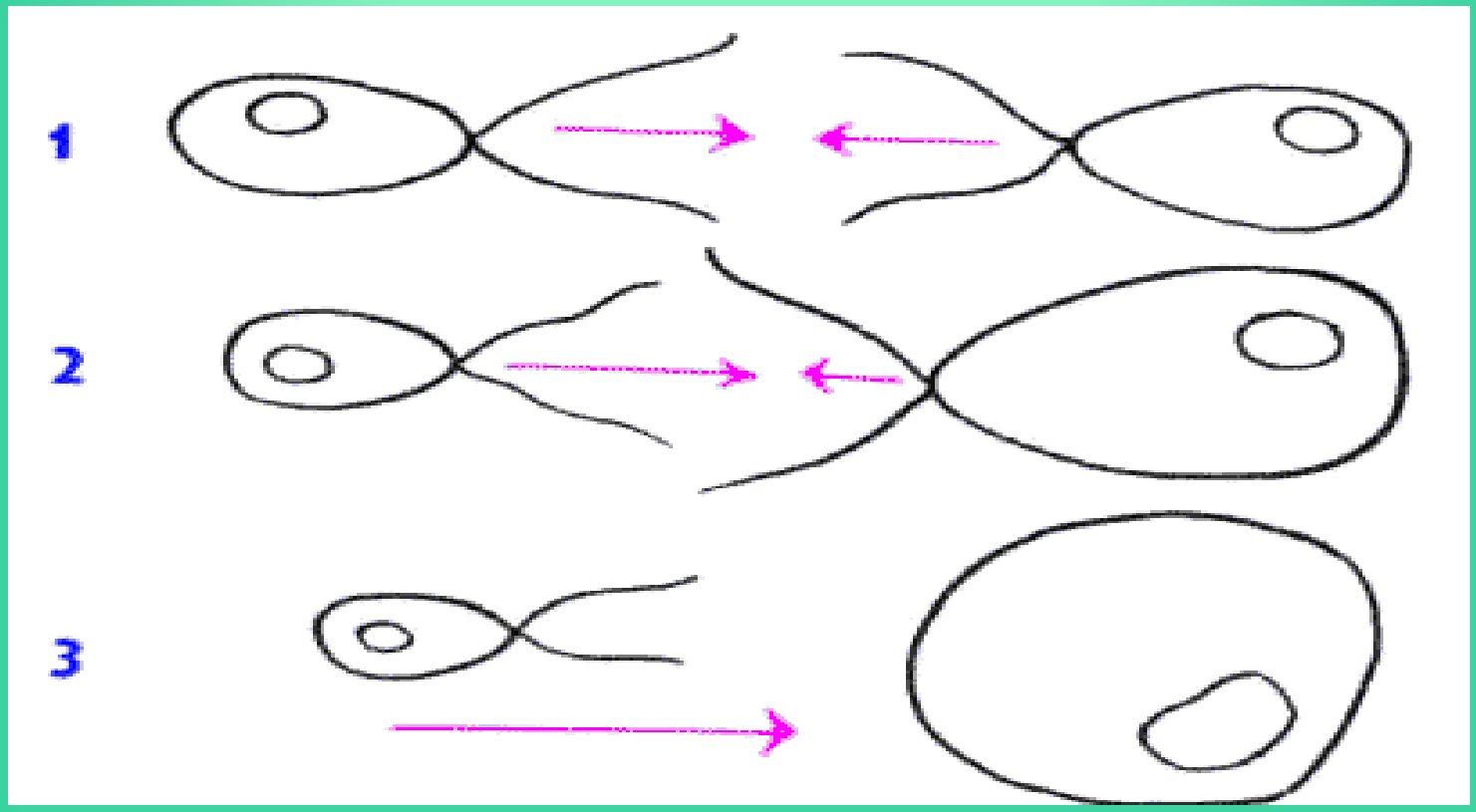
Depending on the aforementioned variety of gametes in the plant world, 3 different methods of fertilization are determined.

1. Isogamy is the fertilization of two gametes (isogametes) of the same size and moving at the same speed. This fertilization occurs in many algae.

2. Heterogamy is the fertilization of two gametes (heterogametes) of various sizes and moving at different rates. Heterogamy occurs in unicellular green algae - chlamydomonads.

3. Oogamy is the fertilization of the ovum and spermatozoon. Thus, the egg cell, in comparison with the spermatozoon, is larger and immobile. There are plenty of reserve nutrients in it; spermatozoon being very small, has the ability to active mobility.

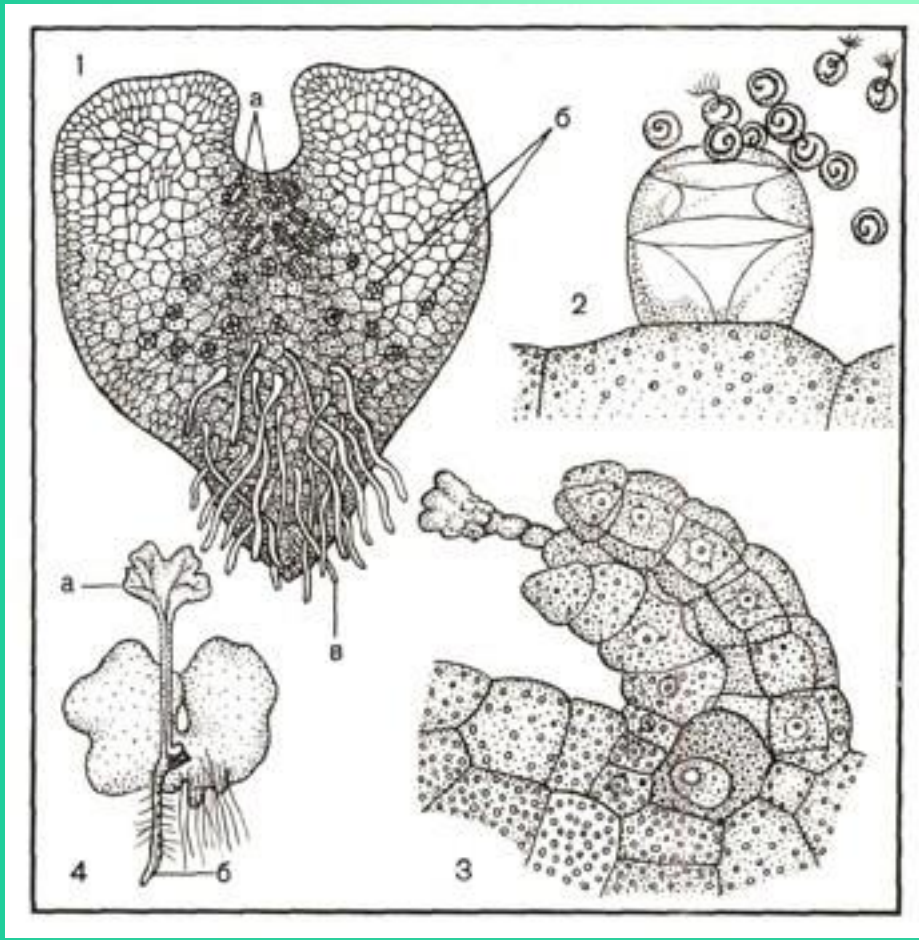
1 - isogamy, 2 - heterogamy, 3 - oogamy



ALTERNATION OF GENERATIONS IN PLANTS AND IT'S BIOLOGICAL IMPORTANCE

Just like the ontogeny of seed plants, i.e. individual development, begins with the seed, so also the individual development of plants, reproduced by spores, begins with a spore, and very often ends with the reproduction of a spore. In any case, in one life cycle, the spore reproduction, that is, asexual, alternates with sexual reproduction; the life cycle that continues after each reproduction is called a sexual or asexual generation.

Alternation of generations of fern



1- gametophyte, а — archegonia, б — antheridia, в — rhizoids;
2 —exit of spermatozoa from antheridium;
3 —archegonia;
4 — sporophyte, а —first leaf, б — rizomes

THANK YOU FOR ATTENTION!

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