**Discipline ”BIOCHEMISTRY AND PLANT PHYSIOLOGY”**

**Guidelines to home tasks**

*Specialty Biology*

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**SIW** 4. Physiology and functions of plant cell organelles. The structure of the plant cell organelles. Significance of water exchange.

***The functions performed by vacuoles.***

1. Water usually enters the concentrated cell sap by osmosis through selectively permeable

tonoplast. As a result, the cell turgor pressure develops and cytoplasm pressed against the cell

wall. Osmotic absorption of water plays an important role in cell elongation during their growth,

and in general the water regime of the plant.

2. Sometimes in the vacuole are present in solution pigments called anthocyanins. This group

includes the anthocyanins, which have red, blue or purple color, and some related compounds,

painted in yellow or cream color. It is these pigments mainly determine the color of flowers (eg,

roses, violets and dahlias), and the color of the fruit, buds and leaves. The leaves, they are

responsible for various shades of autumn color, which, as you know, is also dependent on

photosynthetic pigments contained in chloroplasts. Coloration plays a role in attracting insects,

birds and other animals involved in pollination and seed dispersal.

3. The plants in the vacuoles are sometimes hydrolytic enzymes, and then the life of the cell

vacuoles at act as lysosomes. After the death of the cell tonoplast, like other membrane loses

its selective permeability, and the enzymes are released from the vesicles, causing autolysis.

4. Vacuoles in plants can accumulate wastes and some secondary products of its metabolism.

Of waste are sometimes found, for example, calcium oxalate crystals. The role of secondary

products is not always clear. This applies, in particular, alkaloids, which can be stored in the

vacuoles. It is possible that they, like their astringent tannins taste repel herbivores, ie, serve a

protective function. Tannins particularly common in cell vacuoles (as, indeed, in the cytoplasm

and in the cell walls), leaves, bark, wood, immature fruit and seed shells. Can accumulate in

vacuoles and latex (milky sap), usually in the form of milky emulsion, such as for example

dandelion sap. Some cells (called milky cells) are specialized in the allocation of latex. In the

milky sap of the Brazilian rubber tree contains enzymes and compounds required for the

synthesis of rubber, and in the milk juice of poppy sleeping pills - alkaloids.

5. Some of the components of the cell sap serve as food reserves, if necessary, use the

cytoplasm. Among them in the first place should be called sucrose, minerals and inulin.

*Passive transport is carried out:*

a) through the phospholipid phase, if the substance is soluble in lipids,

b) at intervals between lipids, if gaps appear

c) by lipoprotein carriers,

d) on specialized channels caused by lipoprotein complexes (sodium, potassium and other

channels). Sugars, amino acids and other substrates can be transported by special carriers in

simporte (ie, working together and in the same direction) with the ions H (bacteria, fungi, and

plants) or Na (in animals), and the main driving force in this If the gradient of ions and not the

substrate.

Gases, such as oxygen consumed by cells during respiration, and the resulting CO2 during

respiration, in solution rapidly diffuse through the membrane, moving the diffusion gradient, ie,

from a region of high concentration to areas of low concentration.

Ion and small polar molecules such as glucose, amino acids, fatty acids and glycerol, usually

diffuse through the membrane slowly. Much more quickly pass through the membrane and the

uncharged soluble (lipophilic) molecules.

A modification of this mechanism is the so-called facilitated diffusion, in which the substance

helps to pass through the membrane any particular molecule. In this molecule may be a special

channel that transmits substances only one particular type.

***Channels*** - are transmembrane proteins that act as pores. Sometimes referred to as selective

filters. Transport through the channels, usually passive. Specificity is determined by properties

of the transported substances surface pores. Usually through the channels move ions.

Transport rate depends on their size and charge. If it's time to open, the substances pass

quickly. However, the channels are open always. There is a mechanism "Gates", which under the influence of an external signal to open or close the channel. For a long time seemed difficult to explain the high permeability of the membrane (10 mm / s) for water - the substance of the polar and insoluble in lipids. Today opened integral membrane protein of the channel through the membrane for water penetration - *aquaporins*.

*Aquaporins ability* to transport water is regulated phosphorylation. It was shown that the addition of phosphate groups and return to certain amino acids aquaporins accelerates or inhibits the penetration of water, but do not affect the direction of transport.

*Carriers* - are specific proteins that bind to the substance being transported. In the structure of

these proteins are the group in some way oriented to the outside or the inside. As a result,

changes in the conformation of protein material is transferred in or out. As for the transport of

each individual molecule or non-carrier must change the configuration, the rate of transport of

matter is several times smaller than the transfer takes place through the channels. Shows the

presence of transport proteins in the plasma membrane, not only, but also in the tonoplast.

Transport by carriers may be active or passive. In the latter case, such a transport is in the

direction of the electrochemical potential and does not require energy. This type of transport is

called facilitated diffusion. Thanks transporters it comes with a higher rate than ordinary

diffusion.

Structure roots absorption water and radial transport.

***The structure of the root.***

All features of the morphology and anatomy of the root associated with tneobhodimostyu absorb

water and minerals in the islands of the soil. In the primary structure of the root are several

tissues: root cap, apical meristem rizodermu, primary cortex, endoderm, pericycle and

conductive fabric, concentrated in the central cylinder or stele (Figure).

A growing part of the root is less than 1 cm in length and consists of a meristem (1.5-2 mm from

the tip) and the elongation zone (2-7 mm).

On the tip - root cap cells of the outer layers which secrete mucus in the polysaccharide and

exfoliated when moving root in the soil. Cells of the central part of the Case (statocytes) SOD-t

much amyloplasts filled with starch (statoliths) and involved in the perception of the root

direction of the force of gravity. DOS.

***Mechanisms of root pressure***. In the xylem vessels of water flows due to osmotic pressure.

The existence of such fur-atoms in water transport is proved that if the external environment to

create an osmotic end-tion equal to the intracellular, the water in the cells do not, but if I end-

osmotic up in the environment, water leaves the cell, below - is absorption. Osmotically-active in

your blood vessels and cells. walls are mineral in the islands and the metabolites produced by

active ion pumps, funtsioniruyuschimi plasmolemma in parenchymal cells surrounding the blood

vessels. The accumulation of these in-in creates a suction force, which facilitates the osmotic

water transport in the xylem.

Suction force of the vessels may be higher than that of the surrounding living cells, not only

because of increased concentrations of xylem sap, and a lack of back pressure from the cells.

walls that are in containers lignification, inelastic.

Therefore, In rez of active ion pumps in the root and osmotic (passive) water flowing into the

vessels of the xylem vessels in the developing hydrostatic pressure - the root pressure. It

provides lift xylem Valium on the xylem vessels of the root in oversight. authorities. Fur-m rise of

water in the plant as a result of the developing root pressure-called t lower end engine.

"Lament" plants. "- An example of the lower end engine. Spring can be seen intense xylem fluid

flow upward through the incision of the trunk and even the upper branches of the crown (the

wounded tree "crying." During the "weeping" root pressure reaches 1.013 MPa (10 atm). At

vegetative plants in removing the stem and leaves of the remaining bound with root stump long

enough allocated xylem sap, or PASOK. sap collection method is one of the experimental

methods to study the functioning of the root systems. root pressure can be measured by placing

a pressure gauge on the stump.

**SIW** 6. Significance of macro- and microelements in the plants life.

## Functions of nutrients

At least 17 elements are known to be essential nutrients for plants. In relatively large amounts, the soil supplies nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur; these are often called the macronutrients. In relatively small amounts, the soil supplies iron, manganese, boron, molybdenum, copper, zinc, chlorine, and cobalt, the so-called micronutrients. Nutrients must be available not only in sufficient amounts but also in appropriate ratios.

Plant nutrition is a difficult subject to understand completely, partially because of the variation between different plants and even between different species or individuals of a given clone. Elements present at low levels may cause deficiency symptoms, and toxicity is possible at levels that are too high. Furthermore, deficiency of one element may present as symptoms of toxicity from another element, and vice versa. An abundance of one nutrient may cause a deficiency of another nutrient. For example, K+ uptake can be influenced by the amount of NH+
4 available.

Although nitrogen is plentiful in the Earth's atmosphere, relatively few plants engage in nitrogen fixation (conversion of atmospheric nitrogen to a biologically useful form). Most plants, therefore, require nitrogen compounds to be present in the soil in which they grow.

Carbon and oxygen are absorbed from the air while other nutrients are absorbed from the soil. Green plants obtain their carbohydrate supply from the carbon dioxide in the air by the process of photosynthesis. Each of these nutrients is used in a different place for a different essential function

*Macronutrients (derived from air and water)[*

*Sulfur i*s absorbed by plants in the form of a higher oxide, the main functional form of sulfur in

the plant - restored to the sulfhydryl or disulfide. We have to show the main stages of the

recovery of sulfur in the plant. The functional role of sulfur due to the fact that it is included as a

ligand to a large number of enzymes and metallproteinov. The most famous and important - this

iron-gray-copper-protein and protein. Sulfhydryl groups may directly participate in oxidation-

reduction reactions, or be an important factor in the structure of proteins. We should take up the

role of sulfur in the coenzyme A (CoA) - an important metabolite of the cell.

*Phosphorus* is absorbed by plants in the form of a higher oxide - ion phosphoric acid. Very

important is the ability of phosphorus to form macroergic communication. Needed to

characterize different groups of high-energy phosphate compounds - adenozinpolifosfaty (ATP,

ADP), acetyl (1,3-phosphoglyceric acid) enolfosfaty (phosphoenolpyruvate), polyphosphates.

Phosphorus is an essential component of a number of coenzyme systems (NAD, NADP, FAD).

In addition, phosphorus is part of the nucleic acids, phospholipids. In all these various

compounds phosphorus is in the oxidized form.

*Potassium* is absorbed from the environment in the form of ion K +, in the same form is carried

to all parts of the plants and exerts its physiological effect. Potassium is found primarily in the

ionic form, has a very high mobility and good reutiliziruetsya. Potassium absorption depends

strongly on the content of it in a cage. Should analyze the possible mechanisms of regulation of

the absorption of the element. In discussing the physiological role of potassium to identify the

following issues: the importance of potassium in osmoregulation cells involved in ion

photosynthesis and respiration, activation of potassium enzymatic reactions. Of inorganic

potassium is a major osmotically active and this makes it an important factor of water exchange.

He took part in the ongoing process of admission, transportation, and water evaporation plant,

because of the concentration of potassium in the xylem sap of the root depends on the value of

the pressure. Potassium is involved in stomatal movements. Potassium diet increases the

tolerance of plants to adverse factors. Also multivalent role of potassium in photosynthesis: his

participation is the phosphorylation reaction, potassium enables fixation of CO2 and has a role

in the transport of the products of photosynthesis. A very large number of enzymes require the

presence of potassium for maximum activity. The issue is part of potassium in a conformational

transition of enzymes.

*Magnesium* can be found in the plant in the free diffusion state (70%) or to be associated with

proteins, nucleic acids, phospholipids, polyphosphates. Discussing the physiological role of this

element in the plant, we should show that many enzymatic reactions require magnesium or

stimulated them. This transfer reaction or nucleotide phosphate catalyzed by phosphatases,

kinases, ATP-basics, synthetases, nukleotidtransferazami, and the transport of the carboxyl

groups catalyzed carboxylase. Magnesium is part of chlorophyll, the need to describe the

importance of this element in the molecule. In addition, magnesium is required for ribosome

association and performs a structural role in the stabilization of nucleic acids and membranes.

Interesting is the role of magnesium in the light-dependent regulation of the activity of enzymes

of CO2 fixation in chloroplasts: the outflow of magnesium in the stroma thylakoids to light is an

activator ribulose-bisphosphate carboxylase.

In the role of calcium in the plant, highlight the main features: 1) a low concentration of the

element in the cytoplasm in all eukaryotes, but a lot of the outer surface of plasma membrane,

the cell wall and vacuole, 2) low physiological mobility, which is expressed in the slow rate of

accumulation, transport from cell to cell and phloem transport, and 3) the importance of the

processes of cell signaling as second messengers, and 4) an enzyme cofactor.

Quantitatively, the calcium is preferably in the apoplast. High concentrations within the cell are

usually associated with its concentration in the vacuole in the form poorly soluble salts. In the

apoplast calcium performs a protective role. It creates a favorable balance of elements and pH,

delaying rupture of membranes and leakage of substances from the cell. Calcium is involved in

shaping the structure of the cell wall. Characterized the role of calcium in the structural changes

of the membranes. In this case, it acts as an intermolecular bonding agent. It can (forming

calcium bridges) to interact with the phosphate, carboxyl groups of phospholipids protein. In this

case, the conformation of the membrane and its properties - increased hydrophobicity,

increased stability, reduced permeability to water. Calcium ions have a universal ability to

conduct a variety of signals that have a primary effect on the cell: hormones potogenov, light,

gravity, and stress. Too many external factors lead to a local increase in the concentration of

cytoplasmic calcium and its interaction with various calcium-binding proteins (calmodulin,

calcium-dependent calmodulin-independent protein kinase, protein kinase C), some of which

change their activity, while others convey the effect of this cation to the many molecular targets.

Normal life of the plant organism is possible only under the condition that, apart from the above

macro, they will be provided with trace elements is Fe, Cu, Mo, Zn, As, Mn, Cl, Ni, Co, Na. We

must show the quantitative requirements of the plants in these elements and violations that

occur in plants during their shortcomings. High and varied biological activity of trace elements

due to the fact that they are associated with cell enzyme systems. Some of the trace elements

are directly involved in the construction of the molecules needed for other enzymatic

transformations as a cofactor. They may have an activating effect on the substrate - enzyme

complexes.

*Micro-nutrients*

Plants are able sufficiently to accumulate most trace elements. Some plants are sensitive indicators of the chemical environment in which they grow (Dunn 1991), and some plants have barrier mechanisms that exclude or limit the uptake of a particular element or ion species, e.g., alder twigs commonly accumulate molybdenum but not arsenic, whereas the reverse is true of spruce bark (Dunn 1991). Otherwise, a plant can integrate the geochemical signature of the soil mass permeated by its root system together with the contained groundwaters. Sampling is facilitated by the tendency of many elements to accumulate in tissues at the plant’s extremities.

Iron,

Molybdenum,

Boron,

Copper,

Manganese

**SIW 7** Regulation of plants growth and development. The main factors affecting on these procuresses **Contents:**Cell cycle. Regulation of Cell cycle.

When a cell has grown to its maximum size it divides , and it take place a series of changes in a newly formed cell which involve in growth and division to form 2 daughter cells.

In eukaryotic cells, or cells with a nucleus, the stages of the cell cycle are divided into two major phases: **interphase** and the **mitotic (M) phase**.

**What Cell cycle is?**

***The cell cycle*** is an ordered set of events, culminating in cell growth and division into two daughter cells.

The stages, pictured to the right, are

**G1-S-G2-M**.

Cell cycle

During *interphase*, the cell grows and makes a copy of its DNA.

During the *mitotic (M) phase*, the cell separates its DNA into two sets and divides its cytoplasm, forming two new cells.

Interphase

**G1phase.** During G1, phase, also called the first gap phase, the cell grows physically larger, copies organelles, and makes the molecular building blocks it will need in later steps. *[Do cells always grow before they divide?]*

**S phase.** In S phase, the cell synthesizes a complete copy of the DNA in its nucleus. It also duplicates a microtubule-organizing structure called the centrosome. The centrosomes help separate DNA during M phase.

**G2 phase.** During the second gap phase, or G2, the cell grows more, makes proteins and organelles, and begins to reorganize its contents in preparation for mitosis. G2 phase ends when mitosis begins.

**M phase**

During the mitotic (M) phase, the cell divides its copied DNA and cytoplasm to make two new cells. M phase involves two distinct division-related processes: mitosis and cytokinesis.

Mitosis takes place in four stages: prophase (sometimes divided into early prophase and prometaphase), metaphase, anaphase, and telophase.

REGULATION OF CELL CYCLE

Cell cycle control plays a fundamental role in plants by supporting their largely Post embryonic growth and Development.

Among the bulk of cell cycle players, Cyclin- -dependent kinases coupled with cyclins play a crucial role in the regulation of cell cycle progression

**The main Components**

**Cdk** (cyclin dependent kinase, adds phosphate to a protein), along with cyclins, are major control switches for the cell cycle, causing the cell to move from G1 to S or G2 to M.

**MPF** (Maturation Promoting Factor) includes the CdK and cyclins that triggers progression through the cell cycle.

**p53** is a protein that functions to block the cell cycle if the DNA is damaged. If the damage is severe this protein can cause apoptosis (cell death).

p53 levels are increased in damaged cells. This allows time to repair DNA by blocking the cell cycle.

A p53 mutation is the most frequent mutation leading to cancer.

**p27** is a protein that binds to cyclin and cdk blocking entry into S phase.

*REGULATION OF CELL CYCLE*

G2 Checkpoint

 Control by MPF

Active MPF = Mitotic Cdk + mitotic cyclin

Cdk is cyclin-dependant kinase

MPF controls G2 - M by phosphorylating and activating proteins involving in: Chromosome condensation Nuclear envelope breakdown Spindle assembly It’s own self-destruction

G1 checkpoint

 • Controlled by G1 Cdks-cyclin

• G1 cyclin levels also vary with the cell cycle

• Many additional levels of phosphorylation, dephosphorylation regulate.

Cyclin-Dependent Kinases

A specific class of serine-threonine protein kinases, termed cyclin- dependent kinases (CDKs) due to their activation by association with cyclins, are central regulators of the cell cycle.

Cyclins

The name cyclins (CYCs) stems from the transient and cyclical appearance of these proteins during the cell cycle. Ø CDKs need to be activated by complex formation with cyclins to become functional.

Monomeric CDKs need to be complexed with CYCs and activated via phosphorylation by CDK-activating kinases (CAKs) to be fully functional. CDK Activators Ø CDKD complexed with CYCH or CDKF alone can act as CDK activating kinases in both G1/S and G2/M transitions by phosphorylating CDKA and CDKA/B, respectively.

Auxins and cytokinins supplied with adequate sucrose stimulate the production of the synthesis cyclin, cytokinins stimulate the mitotic cyclin. Abscisic acid interferes with the synthesis CDK-cyclin complex, preventing the cell from cycling.

Description to the scheme

The CDK-cyclin complex also must combine with ATP to be active. This combination is accomplished by yet other cell-cycle control protein, **a protein kinase.** Protein kinases add a phosphate from ATP to a protein...phosphatases remove the phosphate from a protein. The relative balance of protein kinases to phosphatases also helps determine whether the CDK-cyclin complex is active or inactive.

This inactive CDK is produced in G1.

As the cytokinesis is complete, the specialized DNA synthesis cyclin is also made.

Als their concentrations rise, the CDK and cyclin combine.

The combination alters the conformation of the CDK so that an active site is formed for a secondary messenger.

This messenger protein binds and becomes phosphorylated by ATP degradation.

The cell is now competent to go from G1 to S.

The cell begins replicating the DNA.

A new cyclin, the mitotic cyclin, is produced as the synthesis phase ends. This binds with the CDK, altering its conformation to make an active site for a different messenger. The messenger is produced in G2, binds at the active site, and becomes phosphorylated to signal the cell to make the transition from G2 into Mitosis.