.- Biochemistry

Prof. Marco Trevisan

***Text under revision. Not yet approved by academic staff.***

COURSE AIMS AND INTENDED LEARNING OUTCOMES

Biochemistry is the study of the molecular bases of life. It is therefore the science that deals with the composition, structure and function of the molecules typical of living organisms and of the chemical reactions that take place in these organisms. The main objective of the course is to acquire a theoretical knowledge of the main biochemical processes of the soil-plant system. Formulate an understanding of the chemical-physical and biochemical phenomena related to photosynthesis and carbon fixation. Expand students' knowledge on carbohydrates, amino acids and lipids, and develop an understanding of the biochemical phenomena related to plant nutrition. In particular, the mechanisms of transport and cellular communication. Help students understand that biosynthetic and cellular communication mechanisms are interdependent and mediated by chemical signalling molecules.

At the end of the course, students shall be able to discuss the main phenomena related to plant life, such as photosynthesis, nitrogen and carbon fixation, and the use of lipids, and should know how to evaluate the formation of primary and secondary metabolites and the relationships that bind them, and to analyse the adaptations that plant species have developed according to climatic conditions. Knowledge of the mechanisms that regulate energy and matter transformations in plant organisms and the biochemical factors underlying the productivity of cultivated species. The acquired knowledge must be communicated appropriately and discussed critically, demonstrating a critical and analytical understanding and learning ability, and linking the different parts of the course programme, even topics that are not obviously related. Students should also know the criteria and methods for a preliminary assessment of the impact of environmental factors and stress on agricultural productivity.

COURSE CONTENT

|  |  |
| --- | --- |
|  | ECTS |
| Compounds of biochemical interest | 1.5 |
| Water and its properties. Carbohydrates: generalities, classification, properties. Amino acids: generalities, classification, properties. Structure and function of proteins. Nucleotides, structure of DNA and RNA, porphyrin compounds. Lipids: generalities, classification, properties. Complex lipids. Plant wall. |  |
| General information on biochemical processes | 0.75 |
| Enzymes, enzymatic catalysis; reactions catalysed by enzymes: thermodynamics, kinetics and regulation.  Biological membranes and solute transport: thermodynamics, kinetics and transport specificity.  Integration of metabolic networks, function of metabolism, metabolic compartmentation; ATP role, NAD(P)H, concept of cycle and metabolic pathway). |  |
| **Carbohydrate metabolism** | 0.75 |
| Glycolysis and its regulation. Anaerobic fate of pyruvate. Pentose phosphate pathway. Krebs cycle. Mitochondrial electron transport and oxidative phosphorylation and coupling. |  |
| Photosynthesis | 1 |
| The conversion of light energy into chemical energy. The photosynthetic apparatus. Photosynthetic pigments. Light absorption and the photosystem structure. Water photolysis. Photosynthetic electron transport and photophosphorylation. CO2 fixation. Calvin cycle. C2, C3, C4, CAM metabolism and photosynthetic efficacy. Synthesis of sucrose, starch and cellulose. |  |
| Nitrogen and lipid metabolism | 1 |
| Nitrogen fixation. Absorption of nitrate and ammonium. Nitrate reduction. GS/GOGAT ammonium assimilation. Biosynthesis of amino acids. Biosynthesis of nitrogenous bases. Protein metabolism  Biosynthesis of fatty acids, -oxidation of fatty acids, glyoxylate cycle. Complex lipids and biosynthesis of triglycerides (triacylglycerols) and phospholipids. |  |
| Secondary metabolism and mineral nutrition | 1 |
| Secondary metabolism. Terpenes. Polyphenols. Alkaloids.  Biosignaling and cell communication. Plant hormones  Macronutrient and micronutrient functions. Acquisition and use of sulphur, phosphorus, potassium, iron and other microelements |  |
| Practical classes will cover the following topics:  6 hours of classes in which examples and calculations on thermodynamics associated with reactions in cellular biochemistry are addressed: calculation of real G in glycolysis reactions, calculation of E in the main redox of agricultural biochemical interest (respiration, alcoholic fermentation and lactic acid), calculation of G associated with membrane transport and oxidative phosphorylation.  2 hours of classes dedicated to exercises on the use of reactions such as the n-factor calculation for iodine, saponification, determination of molecular weight through colligative properties to hypothesise the best structure of a complex lipid.  1 hour for exercises in determining the structure of a protein using cutting enzymes.  1 hour dedicated to calculating the energy value of foods using thermodynamic calculations and comparing it against the energy value on the nutritional label  2 hours dedicated to depicting the Vmax and KM enzymatic kinetic constants graphically using the Lineweaver-Burk diagram method (or reciprocal double diagram)  Once the explanations are over, students are invited to give examples on the blackboard similar to those dealt with, in order to strengthen their understanding of the topics covered. | 1 |
| 4 Laboratory practicals of 3 hours each.  - Determination of free proline in wine by UV-Vis spectrophotometry  - Analysis of lactose in milk  - Determination of the peroxide number  - Determination of the KM of glucose-oxidase   At the end of each practical task, students will have to write down all the information from the practicala ctivity in a lab notebook and be able to repeat the experience later. | 1 |
|  |  |

READING LIST

**PINTON R., COCUCCI M., NANNIPIERI P., TREVISAN M. *Fondamenti di biochimica agraria,* Patron Editore, Bologna, 2016**

***Plus other texts recommended at the first lecture***

TEACHING METHOD

Lectures alternating with laboratory and guided practical activities in the classroom, intended as an opportunity to study certain parts of the course (as indicated in the programme above) in more depth. All the material presented during lectures will be available to students, after every lecture, on Blackboard.

ASSESSMENT METHOD AND CRITERIA

The assessment will be both written and oral. The written assessment will focus exclusively on the subjects covered in the practical activities and will be preparatory to admission to the oral exam. The written test will involve solving 4 problems linked to the classroom practical activities. Each problem is worth 10 points, 5 for the demonstration of theoretical knowledge and 5 for the calculation itself; a minimum mark of 24/40 is needed to pass the test. The oral exam will be divided into two parts. The first part will consist of 12 closed-ended questions, covering the whole course programme, and will determine if the student continues with the exam or not. The minimum mark for passing this part is 17.5 The oral part will be on the whole course program and will consist of questions on the topics covered in each of the 6 course ECTS. The assessment will take into account the student's ability to understand the topic being discussed, their ability to contextualise it within the course programme, their ability to analyse and explore the topics in depth, and their presentation skill. The final mark will be based one third on the mark obtained for the closed-ended questions and two thirds on the answers given to the oral questions, each of which contributes 1/9 to the final mark.

NOTES AND PREREQUISITES

Participation in the laboratory activities is compulsory. Passing the organic chemistry exam is preparatory to taking the oral exam.

Information on office hours available on the teacher's personal page at http://docenti.unicatt.it/.