General Information	BACELOR DEGREE IN BIOTECHONOLOGIES
Title of the subject	General Chemistry with Stoichiometry
Degree Course (class)	Industrial and Agri-food Biotechnologies (L-2)
ECTS credits	8
Compulsory attendance	Yes
Language	Italian
Academic year	2020/2021

Subject Teacher		
Name and Surname	Antonella Milella	
email address	antonella.milella@uniba.it	
Place and time of reception	Room 309, Department of Chemistry Students can send an email to ask for a meeting. Microsoft Teams Code for Students: b0nx27y	
ECTS credits details	Discipline sector (SSD)	Area
	CHIM/03	03

Study plan schedule	Year of study plan	Semester
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Time management	Lessons	Laboratory	Exercises	Total
CFU	6		2	8
Total hours	150		50	200
In-class study hours	48		24	72
Out-of-class study hours	102		26	128

Syllabus

Prerequisites / Requirements	

Units of measurement and dimensions, basic mathematical knowledge, decimal numbers, powers, logarithms, elementary algebra, 1st and 2nd degree algebraic equations, functions: equation of a straight line, equation of an exponential curve.

Expected learning outcomes (according to Dublin descriptors)

Knowledge and understanding	The final aim of the course is to provide Biotechnology students with the fundamental concepts of Chemistry necessary to interpret biological phenomena on a molecular scale. At the end of the course, the student will be able to trace macroscopic phenomena to the corresponding chemical and physical processes on a microscopic scale, and will learn to represent them in a symbolic way. The main training objectives will be: 1. Writing and reading of the most common chemical

	compounds; 2. Electronic and spatial representation with the description of the bonds in the molecules; 3. Understanding of the molecular structure-reactivity relationship 4. Preparation of solutions of known titre both by direct weighing of pure substances and by dilution of concentrated solutions; 5. Determination of the titer of solutions with unknown concentration; 6. Calculation and measurement of pH; 7. Evaluation of thermodynamic parameters (ΔH, ΔS, ΔG) and electrode potentials in determining the course of reactions; 8. The evaluation of the action mechanism of the solutes in solution in modifying some of the most important chemical-physical parameters: vapor pressure, boiling and solidification temperature, osmotic pressure.
Applying knowledge	The course is integrated with stoichiometric calculus exercises whose function is to accustom the student to evaluate numbers, to take a look at the importance of the quantity of mass of substances involved in chemical processes and to make the concepts of General Chemistry more understandable.
Making informed judgments and choices	Through the acquisition of the basic concepts of Chemistry, the application of the scientific method and the correct use of technical-scientific language, the student will acquire adequate autonomy in evaluating chemical problems and in choosing the most appropriate methods for solving problems.
Communicating knowledge	At the end of the course, the student will be able to explain in a simple, clear and rigorous way the various issues addressed in the course.
Capacities to continue learning	Based on the knowledge acquired during the course, the student will be able to face the subsequent courses of Organic and Analytical Chemistry.
Study Program	
Content	GENERAL ASPECTS. The scientific method. Matter, properties and sizes. International system. Multiple and submultiples. Derived quantities. Mass and weight. Volume and energy. Temperature scales. Classification of matter. States of aggregation of matter. Chemical system, components and phases. Fundamental laws of chemistry (Lavoisier, Proust and Dalton). Atomic symbology. Stable fundamental particles. Atomic number and mass. Isotopes. Atomic masses. Atomic and molecular weight. Avogadro's number. Mole concept. Percentage composition of a system. Exercises. STRUCTURE OF THE ATOM. Thomson's model. The Rutherford model. Theories of light (corpuscular and wave). Light and characteristic waves. Spectrum of electromagnetic radiation. Planck's quantum theory. Emission spectra of atoms. Hydrogen spectra. Bohr's model. Quantization of the rays and energies of the orbits. Sommerfield theory and Zeeman effect. The wave model.

	Heisenberg's uncertainty principle. Hypothesis of De Broglie. Wave function. Schrodinger equation. Quantum numbers. Atomic orbitals, shapes of atomic orbitals, energies of orbitals, Aufbau rules and electronic configurations of the elements. Periodic table and periodic properties: ionization potential, electron affinity, electronegativity. Atomic rays. Metallic font. CHEMICAL BOND. Bond energy, valence, octet rule, oxidation number, coordination number. Bond types: ionic bond, covalent bond in mono and hetero nuclear molecules with the theories of Lewis and V.B. σ and π bonds, expansion of the octet. Stericity of polyatomic molecules: VSEPR method, hybridization of orbitals, resonance. Molecular orbitals theory (diatomic molecules). Metallic bond. Properties and structure of metals. Dipolar bonds: Van der Walls forces, London forces. Hydrogen bond. Hydrogen bond in water. Hydrogen bond and acidity. Hydrogen bond in proteins and DNA. Exercises. NOMENCLATURE. Nomenclature of use and IUPAC of the most common compounds: oxides, hydroxides, anhydrides, oxygenated acids, hydracids, salts. Exercises. CHEMICAL REACTIONS. Acid-base reactions, redox reactions. Oxidants and reducing agents. Balance of re-dox reactions: method of variation of n.o., method of half reactions. Balance in ionic and molecular form. Irreversible reactions. Preparation of salts. Weight ratios in chemical reactions: reactions with limiting reagent. Exercises. STATES OF AGGREGATION OF MATTER. Gaseous state: definition. Atmospheric pressure measurement. Gas pressure measurement. Boyle's law, Charles's law, Gay-Lussac's law, Avogadro's principle. Equation of state of ideal gases. Equation of state of real gases. Compressibility curves of real gases. Gas mixtures. Dalton's law. Kinetic theory of gases. Maxwell-Boltzmann distribution of velocities. Solid state: definition. Solids classification. Covalent solids (atomic and metal). Graphite and diamond: structure-property relationship. Ionic solids: structure-property relationship. Molecular solids: structure-property relationship. Crystalline and amorphous solids. Heating curves of solids. State transitions. Liquid state: definition. Properties of liquids: viscosity, surface tension and vapor pressure. Clausius-Calpeyron equation. Liquid-vapor equilibrium. Le Chatelier's principle. State diagrams. SOLUTIONS. Definition. Ways to express the concentrations of the solutions: molarity, normality, molality, percentage by weight. Molarity-percentage relationship by weight. Preparation of solutions: preparation for direct weighing, preparation for dilution. Dilution and very diluted solutions. Solubility. Solubility of gases. Raoult's law. Colligative properties: ebullioscopic, cryoscopic and osmotic phenomena. Osmotic pressure. Exercises. CHEMICAL THERMODYNAMICS. Internal Energy, Enthalpy, Entropy, Free Energy. Principles of thermodynamics and criteria of spontaneity of chemical reactions. Chemical and thermodynamic equilibrium. Van't Hoff equation. CHEMICAL EQUILIBRIUM. Irreversible and reversible reactions. Kinetic interpretation of the chemical equilibrium. Law of chemical equilibrium. Reaction quotient and equilibrium constant. Relationship between Kp and Kc for a gas equilibrium. Factors affecting a chemical equilibrium: temperature, pressure and concentration. Le Chatelier's

	principle. Degree of advancement. Homogeneous and heterogeneous equilibria. Exercises. CHEMICAL EQUILIBRIUM IN SOLUTION. Conductivity of electrolytic solutions. Equivalent and molar conductivity. Acid-base theories: Arrhenius, Brønsted-Lowry, Lewis. Amphoteric substances. Strength of acids and bases. Monoprotic and polyprotic acids. Monoacid and polyacid bases. Relationship between Ka and Kb of married couples. Water self-protolysis. Leveling effect of water. Acidity of the solutions. pH and acidity scale. Calculation of the pH of solutions containing acidic, basic and neutral solutes. Hydrolysis. Buffer solutions. PH indicators. Acid-base titrations. Strong acid-strong base and weak acid-strong base titration curves. Reactions of precipitation and solubility product. Solubility calculation. Effect of the common ion on the solubility of poorly soluble salts. Exercises. ELECTROCHEMISTRY. Electrode potentials. Batteries and how they work. Pila Daniell. Metal / ion, ion / ion, gas / ion electrodes. Electromotive force of a battery. Measurement of standard potentials. Hydrogen electrode. Standard potential scale. Nernst equation. Concentration batteries. Notes on practical use batteries: Leclanché battery and batteries. pH-meter. Electrolysis. Potential for decomposition. Overvoltage. Ion discharge and discharge order. Electrolysis of water. Electrolysis of molten salts. Faraday's laws. Exercises. CHEMICAL KINETICS. Definition of reaction rate. Average and instantaneous speed. Order of reaction. Kinetic laws for a first and second order reaction. Elementary reactions. Factors influencing the reaction rate: nature of the reactants, concentration, temperature and Arrhenius equation, radiation (hints), catalysts (hints). Mechanism of a reaction according to the theory of collisions and the transition state. Activation energy. Relation between equilibrium constant and rate constants for an elementary reaction. INORGANIC CHEMISTRY. Review of periodic properties. Group I: elements, electronic configuration, main properties. Preparation of sodium by electrolysis of molten salts. Soda-chlorine process. Group II: elements, electronic configuration, main properties. Preparation of calcium by electrolysis of molten salts. Main compounds of Ca. Group III: elements, electronic configuration, main properties. Main compounds of B and Al. Group IV: elements, electronic configuration, main properties. Most important compounds of C and Si. Group V: elements, electronic configuration, main properties. Nitrogen compounds with hydrogen, oxygen. Nitrogen acids. Compounds of phosphorus with hydrogen and oxygen. Acids of phosphorus. Arsenic acids. Group VI: elements, electronic configuration, main properties. Compounds of O. Ozone. Sulfur acids. Group VII: elements, electronic configuration, main properties. Preparation of fluorine. Preparation of chlorine. Halogen acids.
Bibliography and textbooks	1. T.L. Brown, H.H. LeMay, B. Bursten, C. Murphy, P. Woodward, M. E. Stoltzfus, M. W. Lufaso "Fondamenti di Chimica" (EdiSES) 2. P. Giannoccaro, S. Doronzo, "Elementi di Stechiometria" (EdiSES) 3. A.M. Lanfredi, A. Tiripicchio, "Fondamenti di Chimica" (Ambrosiana) 4. M. Giomini, E. Balestrieri, M. Giustini, "Fondamenti di Stechiometria" (EdiSES)
Notes to textbooks	

Teaching methods	The teaching is carried out with lectures using slides that the student can download from the site: https://recascloud.ba.infn.it/ (by connecting to the relative teacher page), and numerical exercises. A collection of exercises, traces of partial tests and in-depth didactic material are also available on the teacher's website.
Assessment methods (oral, written, ongoing assessment)	The exam is aimed at verifying the achievement of the previously specified training objectives. It consists of a written test (also called partial test) and an oral test, carried out on two different days.
Evaluation criteria (describe criteria for each of the above expected outcomes)	With the written test the teacher intends to evaluate the study of the subject and the level of understanding of the main topics of the course. The written task is divided into 9 exercises to be carried out in 3 hours, on the following topics: chemical nomenclature (3 points), writing of compounds and acid-base reactions (3 points), redox balancing and weight calculations (3 points), structural formulas (Lewis, VSEPR, VB) (3 points), gaseous chemical equilibrium (4 points), pH (4 points), dilution or colligative properties (3 points), solubility equilibria (4 points), batteries (3 points). During the test it is allowed to use only calculator and periodic table. Passing the written test takes place with a score of 18/30. During the oral exam the level of knowledge of the course will be further assessed, in particular by evaluating the expository quality, that is the property of language as well as the formalism in the writing of chemical reactions, compounds and mathematical equations, and the ability to connect the acquired knowledge. The oral exam consists of 3 questions on the topics of the course. Based on the number of correct answers and the evaluation criteria set out above, the grade assigned will be as follows: • between 18 and 22 for a correct question • between 23 and 26 for two correct questions • between 27 and 30 for three correct questions The final grade is determined as the arithmetic average between the written and oral marks.
Further information	