



# UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Biomedicina, Neuroscienze e Diagnostica avanzata		
ACADEMIC YEAR	2022/2023		
MASTER'S DEGREE (MSC)	MEDICINE AND SURGERY		
INTEGRATED COURSE	CHEMISTRY AND BIOCHEMISTRY - INTEGRATED COURSE		
CODE	17447		
MODULES	Yes		
NUMBER OF MODULES	2		
SCIENTIFIC SECTOR(S)	BIO/10		
HEAD PROFESSOR(S)	LAURICELLA MARIANNA Professore Ordinario Univ. di PALERMO EMANUELE SONIA Professore Associato Univ. di PALERMO DI LIEGRO ITALIA Professore a contratto in quiescenza Univ. di PALERMO		
OTHER PROFESSOR(S)	CUCCIARDI GIORGIO Professore a contratto Univ. di PALERMO LAURICELLA MARIANNA Professore Ordinario Univ. di PALERMO EMANUELE SONIA Professore Associato Univ. di PALERMO DI LIEGRO ITALIA Professore a contratto in quiescenza Univ. di PALERMO DI GAUDIO FRANCESCA Ricercatore Univ. di PALERMO BUTERA DANIELA Ricercatore Univ. di PALERMO		
CREDITS	12		
PROPAEDEUTICAL SUBJECTS			
MUTUALIZATION			
YEAR	1		
TERM (SEMESTER)	Annual		
ATTENDANCE	Mandatory		
EVALUATION	Out of 30		
TEACHER OFFICE HOURS	<b>BUTERA DANIELA</b> Monday 09:00 11:00 da concordare previo appuntamento via mail <b>DI GAUDIO FRANCESCA</b> Friday 13:00 14:00 DIPARTIMENTO PROMOZIONE DELLA SALUTE, MATERNO INFANTILE DI MEDICINA INTERNA E SPECIALISTICA DI ECCELLENZA - PROMISE - "GIUSEPPE D'ALESSANDRO" - CQRC Via del Vespro n. 133, primo piano <b>DI LIEGRO ITALIA</b> Monday 10:00 12:00 Caltanissetta, CEFPAS, padiglione 3, o Palazzo Moncada. Wednesday 15:00 17:00 Palermo, Viale delle Scienze, Edificio 16 (STEBICEF) Thursday 15:00 17:00 Palermo, Viale delle Scienze, Edificio 16 (STEBICEF) Friday 15:00 17:00 Palermo, Viale delle Scienze, Edificio 16 (STEBICEF) <b>EMANUELE SONIA</b> Thursday 11:00 13:00 Sezione di Biochimica, Dipartimento BioNeC, Policlinico, via del Vespro 129 90127 Palermo <b>LAURICELLA MARIANNA</b> Monday 9:00 11:00 SEzione di Biochimica del BIND		

<b>PREREQUISITES</b>	<p>The prerequisites are those requested at the national level for access to the Course in Medicine and Surgery. In order to be admitted to the Degree Course, indeed, the students must pass a compulsory access competition based on tests that also include questions on chemistry and biochemistry (Ministerial Decree 28 June 2017 No. 476, Annex A).</p> <p>These elements are sufficient for starting the study of the topics of the Integrated Course of Chemistry and Biochemistry.</p>
<b>LEARNING OUTCOMES</b>	<p><b>Knowledge and understanding:</b> The student must know and understand the atomic, molecular, chemical and physical bases of matter, characteristics of the elements and molecules and the principles underlying their chemical-physical behavior, structure and properties of organic compounds e of macromolecules of biological interest. Students will also have to know the biochemical and molecular bases of cellular activities and to understand the mechanisms that regulate metabolic processes. In particular, they will have to know the molecules of biological interest and the main metabolic processes in which they are involved, to know and understand the mode of action of enzymes, the bases of their regulation and catalysis, the bases of bioenergetic, and the general mechanisms of extracellular signal transduction..</p> <p><b>Ability to apply knowledge and understanding:</b> The student must know how to apply the acquired knowledge for interpreting the behavior of molecules in the biological field and the ability for understand the mechanisms underlying metabolic processes of life.</p> <p><b>Making judgments:</b> Students must be able to acquire knowledge that allows evaluation of the interactions that link different metabolic processes, and of the possible effects of xenobiotic substances.</p> <p><b>Communication skills:</b> The student must know how to present with an appropriate technical-scientific language the topics addressed in the course.</p> <p><b>Learning skills:</b> The student must develop a methodology for his/her scientific studies, that allows to interpret and deepen the biochemical aspects of pathologies; he/she must acquire the ability to integrate the acquired knowledge and to show a critical approach and a research-oriented attitude, demonstrating the ability of personal judgments in solving analytical problems and independently search for scientific information.</p>
<b>ASSESSMENT METHODS</b>	<p>The assessment is based on two intermediate tests (one on chemistry and the other on biochemistry) and a final optional oral exam that consists in a conversation aimed to further ascertain the knowledge and full understanding of the topics of the Course and the learning and speaking capability of the student. The Chemistry intermediate test consists in a written questionnaire on biologic buffers, acid-base and osmotic equilibrium, solubility, oxide-reduction and an oral exam including all the topics of the module.</p> <p>The Biochemistry intermediate test is based on 31 multiple choice questions including a part to explain the answer given.</p> <p>The two intermediate tests occur in different days and before the Integrate final exam. To pass the exam, the student must obtain a final mark included within 18 and 30 cum laude.</p> <p>The threshold of sufficiency will be reached when the student shows knowledge and understanding of the topics of both modules at least in general, and shows just sufficient skills. The student needs to show speaking ability such that the examiner can understand his/her knowledge. Below this threshold the exam will be insufficient.</p> <p>The passing of the intermediate tests is mandatory for the access to the oral exam. As previously mentioned, this latter is optional: the student can directly accept the marks deriving from the average of the marks obtained in the two tests or undergo the oral exam to improve the final mark.</p> <p>The evaluation marks will be proportional to the student's ability to interact with the examiner and to show knowledge and capability.</p> <p><b>Evaluation and criteria:</b></p> <ul style="list-style-type: none"><li>- Excellent (ECTS grade A/A+, excellent): Excellent knowledge of the topics of the Integrated Course and their possible applications in the lab. The student shows high analysis-synthesis capability and is able to apply his/her knowledge to solve complex problems. Mark: 30- 30 cum laude</li><li>- Very good (ECTS grade B, very good): Very good knowledge of the topics of the Course and speaking ability. The student shows good analysis-synthesis capability, and is able to apply his/her knowledge to solve middle-high level problems. Mark: 27-29</li></ul>

	<ul style="list-style-type: none"> <li>- Good (ECTS grade C, good): good knowledge of the topics of the course and good speaking ability. The student is able to apply his/her knowledge to solve middle level problems. Mark: 24 – 26</li> <li>- Satisfactory (ECTS grade D satisfactory): knowledge of the topics of the course is satisfactory but, in most cases, limited to the principal subjects. Acceptable capability to employ the specific language of the matter and to apply knowledge. Mark: 21 – 23</li> <li>- Sufficient (ECTS grade E sufficient): Minimal knowledge of the topics of the Course, often limited to principal subjects. Modest ability to employ the specific language on the matter and to apply knowledge. Mark: 18-20</li> <li>- Insufficient: (ECTS grade F, fail): The student does not have an acceptable knowledge of the topics of the Course. The ability to employ the specific language of the matter and to apply knowledge is scarce. Exam failed.</li> </ul>
<b>TEACHING METHODS</b>	Frontal lectures and written exercises.

<b>PREREQUISITES</b>	<p>The pre-requisite are established at a National level for the access to the unique cycle Degree Course in Medicine and Surgery. In fact, to be allowed at the Degree Course the students have to pass a compulsory access exam, that is based on tests including also questions of chemistry and biochemistry. (DM 28 giugno 2017 n. 476, Allegato A). In order to understand the topics of the Integrated Course in Chemistry and Biochemistry, these basis are sufficient.</p>
<b>LEARNING OUTCOMES</b>	<p>The students should know and understand: i) the basic atomic, molecular, and physicochemical properties of matter, ii) the characteristics of the elements and molecules and the principles which underlie their chemical and physical behavior; iii) the structures and properties of the main organic compounds and biological macromolecules. The students should also know the biochemical and molecular bases of cellular activities and understand the mechanisms that regulate the metabolic processes. In particular, they should know: i) the main biological molecules and the metabolic processes in which they are involved; ii) the mode of action of enzymes, and the principles of enzyme catalysis and regulation; iii) the bases of bioenergetics and iv) the general mechanisms of extracellular signal transduction.</p> <p>The students should be able to apply their knowledge for interpreting the behavior of biological molecules and understanding the molecular mechanisms which underlie the metabolic processes and life.</p> <p>The students should acquire autonomy in the learning process in order to become able to evaluate possible interactions among the different metabolic processes and xenobiotics.</p> <p>The students should be able to express the basics of acquired knowledge by both written and oral essays, with scientific-technical language appropriate to the topics discussed.</p> <p>The students should develop a scientific learning methodology which allows them to interpret and further investigate the biochemical problems arising in the continuation of their studies and career; they should acquire the ability to integrate all the acquired knowledge by also showing a critical approach to biological problems and an attitude towards the scientific research. Finally, they should be able to propose solutions for analytical problems, and to search autonomously for updated scientific information.</p>
<b>ASSESSMENT METHODS</b>	<p>The assessment is based on two intermediate tests (one on chemistry and the other on biochemistry) and a final optional oral exam that consists in a conversation aimed to further ascertain the knowledge and full understanding of the topics of the Course and the learning and speaking capability of the student. The Chemistry intermediate test consists in a written questionnaire on biologic buffers, acid-base and osmotic equilibrium, solubility, oxide-reduction and an oral exam including all the topics of the module.</p> <p>The Biochemistry intermediate test is based on 31 multiple choice questions including a part to explain the answer given.</p> <p>The two intermediate tests occur in different days and before the Integrate final exam. The evaluation is in thirty. To pass the exam, the student must obtain a final mark included in 18 and 30 cum laude.</p> <p>The threshold of sufficient will be reached when the student shows knowledge and understanding of the topics of both modules at least in general and has just sufficient skills; The student needs speaking ability as well so that the examiner can understand his/her knowledge. Below this threshold the exam will be insufficient.</p> <p>The passing of the intermediate tests is obligated for the access to the oral exam. As previously mentioned, the latter is optional: the student might directly accept the mark deriving from the media of the marks obtained in the two tests or make a further oral exam to improve the final mark.</p> <p>As the student manage to interact with the examiner and shows knowledge and capability, as the evaluation will be positive.</p> <p>Evaluation and criteria:</p> <p>Excellent (ECTS grade A/A+, excellent): Excellent knowledge of the topics of the Integrated Course and possible applications in the lab. The student shows high analysis- synthesis capability and is able to apply knowledge to solve complex problems. Mark: 30- 30 cum laude</p> <p>Very good (ECTS grade B, very good): Very good knowledge of the topics of the Cours and speaking ability. The student shows good analysis- synthesis capability is able to apply knowledge to solve middle-high level problems. Mark: 27-29</p> <p>Good (ECTS grade C, good): good knowledge of the topics of the course and goof speaking ability. The student is able to apply knowledge to solve middle level problems. Mark: 24 – 26</p> <p>Satisfactory (ECTS grade D satisfactory): satisfactory knowledge of the topics of the course but in most cases, limited to the principal subjects. Acceptable</p>

	<p>capability to employ a specific language of the matter and to apply knowledge. Mark: 21 – 23</p> <p>Sufficient (ECTS grade E sufficient): Minimal knowledge of the topics of the Course often limited to principal subjects. Modest ability to employ a specific language on the matter and to apply knowledge. Mark: 18-20</p> <p>Insufficient: (ECTS grade F, fail): The student does not have an acceptable knowledge of the topics of the Course. Scarce the ability to employ a specific language on the matter and to apply knowledge. Exam failed</p>
<b>TEACHING METHODS</b>	Frontal lectures

<b>PREREQUISITES</b>	<p>The prerequisites are those established at national level for access to the course single-cycle degree in Medicine and Surgery. To be admitted to the In fact, these students must pass an admission competition mandatory, based on tests that also include chemistry questions e biochemistry (Ministerial Decree No. 476 of 28 June 2017, Annex A).</p> <p>To understand the topics of the Integrated Course of Chemistry and Biochemistry are these elements are sufficient.</p>
<b>LEARNING OUTCOMES</b>	<p>Knowledge and understanding: The student should know and understand the atomic, molecular and bases physico-chemical of matter, the characteristics of the elements and molecules and the principles underlying their chemical-physical behavior, the structure and the properties of organic compounds and macromolecules of biological interest. The students should also know the biochemical and molecular basis of cellular activities and understanding the mechanisms that regulate metabolic processes. In particular, they should know the molecules of biological interest and main metabolic processes in which they are involved; know and understand the mode of action of enzymes, the basis of their regulation and catalysis, the basics of bioenergetics and the general mechanisms of signal transduction extracellular.</p> <p>Ability to apply knowledge and understanding: The student should know how to apply the knowledge acquired to interpret the behavior of molecules in the biological field and have the ability to understand the molecular mechanisms underlying metabolic processes and life.</p> <p>Autonomy of judgment: The student should how to acquire cognitive autonomy that allows him to evaluate the interactions between the different processes metabolic and the possible effects of xenobiotic substances.</p> <p>Communication skills: The student must be able to present orally and in writing, with language appropriate scientific technician, the topics addressed.</p> <p>Learning skills: The student must develop a methodology of scientific study that allows him to know how to interpret and deepen the biochemical problems that will arise in the continuation of the study career; must acquire the ability to integrate the acquired knowledge and show a critical approach and a research-oriented attitude, proving to be able to make personal judgments to resolve analytical problems and knowing how to independently search for scientific information.</p>
<b>ASSESSMENT METHODS</b>	<p>The evaluation includes two intermediate tests (one of chemistry and one of biochemistry) and a final oral exam, which consists of the final evaluation integrated course with an optional interview, optional for the student, aimed at further deepening both knowledge and full understanding of the topics covered in the course, both the elaborative and expository skills of the candidate. The Chemistry mid-term exam will consist of a written exam on biological buffers, acid base, osmotic, solubility and redox balances and in an oral test on all the topics of the Module. The intermediate test of biochemistry consists of 31 multiple choice questions which may include one part in which you are asked to briefly explain the reasons for the choice done. The two intermediate tests take place on different days and before the exam final integrated. Passing the intermediate tests is mandatory for access to the integrated final oral exam. As mentioned, during the final test, it is student can directly accept the grade deriving from the average of the grades reported in the two tests or undergo a further oral interview, aimed at improving the overall grade.</p> <p>The evaluation is out of thirty. To pass the exam, the candidate must obtain an overall final grade between 18 and 30 with honors. The threshold sufficiency will be reached when the student shows knowledge e understanding of the topics of both modules at least in general lines e has sufficient application skills; he will also have to possess skills expositive such as to allow the reasoned transmission of their own knowledge. Below this threshold, the examination will be insufficient. How much more the examiner will be able to interact with the examiner, and as much as his own knowledge and application skills will go into the detail of the discipline subject to verification, the more the evaluation will be positive.</p> <p>Evaluation and its criteria: The evaluation is out of thirty, as shown in the following scheme: -Vote: 30 - 30 e lode - Evaluation: Excellent (ECTS grade A-A + excellent) Outcome: Excellent knowledge of the contents of the Integrated Course and of any Laboratory activities. The student demonstrates a high analytical-synthetic ability and is able to apply knowledge to solve high problems complexity. -Vote: 27 - 29 - Evaluation: Excellent (ECTS grade B very good) Outcome: Excellent knowledge of teaching content and excellent language properties. The student demonstrates analytical-synthetic ability and is able to apply the knowledge to solve problems of average complexity and, in some cases, also high.</p>

	<p>- Grade: 24 - 26 - Assessment: Good (ECTS grade C Good) Outcome: Good knowledge of teaching content and good language skills. The student is able to apply knowledge to solve media problems complexity.</p> <p>Grade: 21 - 23 - Assessment: Fair (ECTS grade D satisfactory) Outcome: Fair knowledge of the teaching contents, in some cases limited to main topics. Acceptable ability to use the specific language of discipline and to apply independently the acquired knowledge.</p> <p>- Grade: 18 - 20 - Assessment: Sufficient (ECTS grade E sufficient) Outcome: Minimum knowledge of teaching contents, often limited to main topics. Modest ability to use the specific language of discipline and to independently apply the acquired knowledge.</p> <p>- Score: &lt;18 - Evaluation: Insufficient (ECTS grade F Fail) Outcome: Not possess an acceptable knowledge of the main teaching contents. Very little or no ability to use the specific language of the discipline e to independently apply the acquired knowledge. Failed exam.</p>
<b>TEACHING METHODS</b>	Lectures and written exercises

## MODULE CHEMISTRY AND INTRODUCTORY BIOCHEMISTRY

*Prof. GIORGIO CUCCIARDI - Sede HYPATIA, - Sede HYPATIA*

### SUGGESTED BIBLIOGRAPHY

CHIMICA E PROPEDEUTICA BIOCHIMICA con inclusi il kit di modellistica molecolare.

F. A. Bettelheim, W. H. Brown, M. K. Campbell, S. O. Farrell, O. J. torres

Edizione II/2014

ISBN9788879598415

EDISES

Stechiometria dal testo di M. Freni e A. Sacco

A. Caselli, S. Rizzato, F. Tessore

ISBN9788879598835

Edizione V

EDISES

TESTI DI APPROFONDIMENTO:

CHIMICA

J. C. Kotz, P. M. Treichel, J. R. Townsend, D. A. Treichel - CHIMICA - VI edizione 2017

ISBN9788879599665

EDISES

G. ALONSO ESERCIZI DI CHIMICA EDIERMES non piu' in stampa

Dispense fornite dal docente sotto forma di file in pdf o articoli scientifici.

Supplements provided by the teacher in the form of pdf files or scientific articles.

<b>AMBIT</b>	50423-Struttura, funzione e metabolismo delle molecole d'interesse biologico
<b>INDIVIDUAL STUDY (Hrs)</b>	90
<b>COURSE ACTIVITY (Hrs)</b>	60

### EDUCATIONAL OBJECTIVES OF THE MODULE

Knowing the atomic and molecular basis of matter

Knowing the atomic and molecular basis of life processes

Know the characteristics of the elements and molecules present in biological systems and the underlying principles of their behavior in order to understand human metabolic processes

## SYLLABUS

Hrs	Frontal teaching
2	CALCULATIONS AND MEASURES: Introduction, Scientific Method, Matter, Measurement Systems, Main units' measurement, Accuracy, Accuracy, Errors, significant expressions and notations Scientific, Significant Figures in Calculations.
4	ATOMS, MOLECULES AND ATOMIC MODELS: Introduction, Atomic Structure, Electronic Configurations, and energy levels Sublayers, octet rule, Electronic filling, Periodic Table, Orbital and MO theory, properties' periodical.
4	CHEMICAL BOND AND FORCES INTERMOLECULAR: the theory of the chemical bond, Covalent compounds, ionic compounds, polyatomic ions, complexes and coordination compounds, nomenclature, geometry of molecules, Polarity, Existing types of forces between ionic and polar compounds, hydrogen bonding, Lewis structures.
4	CHEMICAL REACTION: Classification of chemical reactions, chemical Read, balance equations, number of oxidation and redox reactions, homogeneous and heterogeneous reactions, ionic equations, weighting term, excess reagents and limiting.
4	STATES OF MATTER: Kinetic and Potential Energy, State Solid, Liquid State, Gaseous State, Plasma, status changes.
4	SOLUTIONS: Types, modes of expressing the concentration and stoichiometry of solutions, Solubility, Aqueous Solutions, Vapor Pressure, Property 'Colligative, osmosis, dialysis, Sol, Gels and Colloids.
2	THERMODYNAMICS AND KINETIC: Thermodynamic and Read thermodynamic properties of chemical interest, speed 'reaction, chemical equilibrium, catalysis, equilibrium, Le Chatelier's Principle.
3	ACID BASES AND SALTS: acid-base theories, acids and bases and their properties, Strength of acid-base equilibria, pH and pOH, salts and their hydrolysis, titration, swabs and biological buffers.
1	NUCLEAR REACTIONS: Introduction, Main types of radiation, half-time, fission and fusion, Radioactive Isotopes - Medical Applications - field radiation safety.



4	ALKANES: Carbon Hybridization; Alkanes, formulas, nomenclature, structures, conformations, isomers and stereoisomers, Cycloalkanes, sources and reactions, combustion and halogenation of alkanes, alkyl halides; Activities 'optical, Racemi, compounds with more' chiral centers, racemes Resolution expiry stereochemical in the formation of chiral centers.
4	HYDROCARBONS UNSATURATED: Property, Alkenes and Nomenclature, Alkynes and Nomenclature, geometric isomers, Reactions of Alkenes and Alkynes, conjugated dienes, allyl systems, Electrophilic addition to alkenes and alkynes, catalytic hydrogenation, polymerization, Aromatic Hydrocarbons and reactions. Molecules of biological interest.
2	Alkyl halides: Nucleophilic Substitution and Elimination reactions, Grignard reagents.
4	AROMATIC COMPOUNDS: aroma 'and Eteroaromaticita, Benzene and derivatives, electrophilic aromatic substitution, electronic effects of the substituents, phenols and quinones, aryl halides, amines: structure and reactivity, heterocyclic compounds: pyrrole, Imidazole, pyridine, Pyrimidine, Purine, tautomerism structures heterocyclic.
1	ALCOHOL: alcohols, diols, glycerol, synthetic routes and reactions. Molecules of biological interest.
3	CARBONYL COMPOUNDS: aldehydes and ketones, nucleophilic Addition, hemiacetals, acetals, cyanohydrin, Imines, Enamines. Oxidation and reduction, acidity 'of the hydrogens in keto-enol tautomerism, carbanions, aldol condensations. Molecules of biological interest.
3	CARBOXYLIC ACIDS AND DERIVATIVES: carboxylic acids and their derivatives, nucleophilic substitution acyl chlorides of acids, amines and Starches, anhydrides, esters, Thioesters, Claisen condensation, esterification and hydrolysis of esters, oxo, keto acids, dicarboxylic acids, esters and anhydrides biological importance
4	Carbohydrates: monosaccharides, steric Series, cyclic structures, Mutarotation, glycoside bond, glycosides, oxidation, reduction, Reducing sugars, ribose, Deoxyribose, glucose, galactose, mannose, fructose, disaccharides (maltose, cellobiose, lactose, sucrose), polysaccharides (Amilosis , Amylopectin, cellulose, glycogen), amino sugars.
3	Lipids: Saturated and unsaturated fatty acids omega 3 and omega 6, simple and complex lipids, terpenes and steroids, phospholipids, biological role of lipids, detergents and soaps, lipids related to food
2	Proteins: Amino acids: structure and configuration, acid-base equilibria of amino acids and peptides, isoelectric point and isoionic, Bond peptide - peptide structures, synthesis of polypeptides, enzymes. Molecules of biological interest.
2	Clinical chemistry and quality control of analytical data

## MODULE CHEMISTRY AND INTRODUCTORY BIOCHEMISTRY

*Prof.ssa DANIELA BUTERA - Sede IPPOCRATE, - Sede IPPOCRATE*

### SUGGESTED BIBLIOGRAPHY

Butera/Lauricella La chimica organica e le macromolecole biologiche. Piccin  
Whitten Chimica Piccin  
Kotz e Purcell Chimica Edises

CHIMICA E PROPEDEUTICA BIOCHIMICA con inclusi il kit di modellistica molecolare.

F. A. Bettelheim, W. H. Brown, M. K. Campbell, S. Farrell

EDISES

Alonso Esercizi di chimica Ediermes non più in stampa

Stechiometria dal testo di M. freni e A. Sacco Edises

proiezioni in powerpoint fornite dal docente

<b>AMBIT</b>	50423-Struttura, funzione e metabolismo delle molecole d'interesse biologico
<b>INDIVIDUAL STUDY (Hrs)</b>	90
<b>COURSE ACTIVITY (Hrs)</b>	60

### EDUCATIONAL OBJECTIVES OF THE MODULE

To supply to the student the basic knowledges of general chemistry and the necessary instruments to being able to comprise the properties of organic compounds and the macromolecules of biological interest.

## SYLLABUS

Hrs	Frontal teaching
2	Calculations and measurements: Introduction, scientific method, Materia, measuring systems, main unit of measurement, accuracy, precision, Errors, significant expressions and scientific notations, significant digits in calculations.
4	Atoms and molecules: Introduction, periodic table, electron configurations, energy levels and Sublevels, octet rule, orbital, electronic filling, periodic properties.
4	CHEMICAL BOND AND INTERMOLECULAR FORCES: ionic compounds, Covalent compounds, Poliatomic Ions, Nomenclature, geometry of molecules, Polarity, types of forces that exist between the polar and Ionic compounds, hydrogen bond
4	Chemical reactions: Balancing equations, classification of chemical reactions, Redox Reactions, oxidation number and other classes of reactions, ionic Equations, weight, limiting Reagents.
4	SOLUTIONS AND COLLOIDS: Solubility, Ways of expressing concentration, Stechiometry of solutions, Aqueous Solutions, colligative properties, Osmosis, Vapor Pressure, Colloids, Dialysis.
4	STATES OF MATTER: Kinetic and Potential Energy, State Solid, Liquid State, Gaseous State, State changes
3	ACID BASES AND SALTS: acid-base theories, acids and bases and their properties, Strength of acid-base equilibria, pH and pOH, salts and their hydrolysis, titration (notes), swabs and biological buffers
2	SPEED 'REACTION AND CHEMICAL BALANCE: Thermodynamics, kinetics, catalysis, chemical equilibrium, Le Chatelier's principle
1	NUCLEAR REACTIONS: Introduction, Main types of radiation, half-time, fission and fusion, the main uses of radioactive isotopes, Medical Applications, field radiative Security
4	ALKANES: Carbon, formulas, structures and isomers, Alkanes and Nomenclature Cycloalkanes, sources and reactions, halides alchilic
4	HYDROCARBONS UNSATURATED: Property, Alkenes and Nomenclature Alkanes and Nomenclature, geometric isomers, Reactions of Alkenes, aromatic hydrocarbons
2	Alkyl halides: Nucleophilic Substitution and Elimination reactions, Grignard reagents.
4	AROMATIC COMPOUNDS: aroma 'and Eteroaromaticita, Benzene and derivatives, electrophilic aromatic substitution, electronic effects of the substituents, phenols and quinones, aryl halides, amines: structure and reactivity, heterocyclic compounds: pyrrole, Imidazole, pyridine, Pyrimidine, Purine, tautomerism structures heterocyclic.
1	ALCOHOL: alcohols, diols, glycerol, synthetic routes and reactions.
4	CARBONYL COMPOUNDS: aldehydes and ketones, nucleophilic Addition, hemiacetals, acetals, cyanohydrin, Imines, Enamines. Oxidation and reduction, acidity 'of the hydrogens in keto-enol tautomerism, carbanions, aldol condensations.
3	CARBOXYLIC ACIDS AND DERIVATIVES: carboxylic acids and their derivatives, nucleophilic substitution acyl chlorides of acids, amines and Starches, anhydrides, esters, Thioesters, Claisen condensation, esterification and hydrolysis of esters, oxo, keto acids, dicarboxylic acids, esters and anhydrides biological importance

3	Carbohydrates: monosaccharides, steric Series, cyclic structures, Mutarotation, glycoside bond, glycosides, oxidation, reduction, Reducing sugars, ribose, Deoxyribose, glucose, galactose, mannose, fructose, disaccharides (maltose, cellobiose, lactose, sucrose), polysaccharides (Amilosis , Amylopectin, cellulose, glycogen), amino sugars.
3	Lipids: Saturated and unsaturated fatty acids omega 3 and omega 6, simple and complex lipids, terpenes and steroids, phospholipids, biological role of lipids, detergents and soaps, lipids related to food
2	Proteins: Amino acids: structure and configuration, acid-base equilibria of amino acids and peptides, isoelectric point and isoelectric, Bond peptide - peptide structures, synthesis of polypeptides, enzymes.
2	clinical chemistry and quality control of analytical data

## MODULE CHEMISTRY AND INTRODUCTORY BIOCHEMISTRY

*Prof.ssa FRANCESCA DI GAUDIO - Sede CHIRONE, - Sede CHIRONE*

### SUGGESTED BIBLIOGRAPHY

CHIMICA E PROPEDEUTICA BIOCHIMICA con inclusi il kit di modellistica molecolare.  
F. A. Bettelheim, W. H. Brown, M. K. Campbell, S. O. Farrell, O. J. torres - Di Gaudio - Bono  
Edizione II/2014 - ISBN9788879598415 - EDISEs

Chimica - Kotz e Purcell Edises

Chimica Whitten -Piccin

La chimica organica e le macromolecole biologiche. Butera Lauricella Piccin-Nuova Libreria

Stechiometria dal testo di M. Freni e A. Sacco

A. Caselli, S. Rizzato, F. Tessore

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<b>AMBIT</b>	50423-Struttura, funzione e metabolismo delle molecole d'interesse biologico
<b>INDIVIDUAL STUDY (Hrs)</b>	90
<b>COURSE ACTIVITY (Hrs)</b>	60

### EDUCATIONAL OBJECTIVES OF THE MODULE

Knowing the atomic and molecular basis of matter

Knowing the atomic and molecular basis of life processes

Know the characteristics of the elements and molecules present in biological systems and the underlying principles of their behavior in order to understand human metabolic processes

## SYLLABUS

Hrs	Frontal teaching
2	CALCULATIONS AND MEASURES: Introduction, Scientific Method, Matter, Measurement Systems, Main units' measurement, Accuracy, Errors, significant expressions and notations Scientific, Significant Figures in Calculations.
4	ATOMS, MOLECULES AND ATOMIC MODELS: Introduction, Atomic Structure, Electronic Configurations, and energy levels Sublayers, octet rule, Electronic filling, Periodic Table, Orbital and MO theory, properties' periodical.
4	CHEMICAL BOND AND FORCES INTERMOLECULAR: the theory of the chemical bond, Covalent compounds, ionic compounds, polyatomic ions, complexes and coordination compounds, nomenclature, geometry of molecules, Polarity, Existing types of forces between ionic and polar compounds, hydrogen bonding, Lewis structures.
4	CHEMICAL REACTION: Classification of chemical reactions, chemical Read, balance equations, number of oxidation and redox reactions, homogeneous and heterogeneous reactions, ionic equations, weighting term, excess reagents and limiting.
4	STATES OF MATTER: Kinetic and Potential Energy, State Solid, Liquid State, Gaseous State, Plasma, status changes.
4	SOLUTIONS: Types, modes of expressing the concentration and stoichiometry of solutions, Solubility, Aqueous Solutions, Vapor Pressure, Property 'Colligative, osmosis, dialysis, Sol, Gels and Colloids.
2	THERMODYNAMICS AND KINETIC: Thermodynamic and Read thermodynamic properties of chemical interest, speed 'reaction, chemical equilibrium, catalysis, equilibrium, Le Chatelier's Principle.
3	ACID BASES AND SALTS: acid-base theories, acids and bases and their properties, Strength of acid-base equilibria, pH and pOH, salts and their hydrolysis, titration, swabs and biological buffers.
1	NUCLEAR REACTIONS: Introduction, Main types of radiation, half-time, fission and fusion, Radioactive Isotopes - Medical Applications - field radiation safety.

4	ALKANES: Carbon Hybridization; Alkanes, formulas, nomenclature, structures, conformations, isomers and stereoisomers, Cycloalkanes, sources and reactions, combustion and halogenation of alkanes, alkyl halides; Activities 'optical, Racemi, compounds with more' chiral centers, racemes Resolution expiry stereochemical in the formation of chiral centers.
4	HYDROCARBONS UNSATURATED: Property, Alkenes and Nomenclature, Alkynes and Nomenclature, geometric isomers, Reactions of Alkenes and Alkynes, conjugated dienes, allyl systems, Electrophilic addition to alkenes and alkynes, catalytic hydrogenation, polymerization, Aromatic Hydrocarbons and reactions. Molecules of biological interest.
2	Alkyl halides: Nucleophilic Substitution and Elimination reactions, Grignard reagents.
4	AROMATIC COMPOUNDS: aroma 'and Eteroaromaticita, Benzene and derivatives, electrophilic aromatic substitution, electronic effects of the substituents, phenols and quinones, aryl halides, amines: structure and reactivity, heterocyclic compounds: pyrrole, Imidazole, pyridine, Pyrimidine, Purine, tautomerism structures heterocyclic.
1	ALCOHOL: alcohols, diols, glycerol, synthetic routes and reactions. Molecules of biological interest.
3	CARBONYL COMPOUNDS: aldehydes and ketones, nucleophilic Addition, hemiacetals, acetals, cyanohydrin, Imines, Enamines. Oxidation and reduction, acidity 'of the hydrogens in keto-enol tautomerism, carbanions, aldol condensations. Molecules of biological interest.
3	CARBOXYLIC ACIDS AND DERIVATIVES: carboxylic acids and their derivatives, nucleophilic substitution acyl chlorides of acids, amines and Starches, anhydrides, esters, Thioesters, Claisen condensation, esterification and hydrolysis of esters, oxo, keto acids, dicarboxylic acids, esters and anhydrides biological importance
4	Carbohydrates: monosaccharides, steric Series, cyclic structures, Mutarotation, glycoside bond, glycosides, oxidation, reduction, Reducing sugars, ribose, Deoxyribose, glucose, galactose, mannose, fructose, disaccharides (maltose, cellobiose, lactose, sucrose), polysaccharides (Amilosis , Amylopectin, cellulose, glycogen), amino sugars.
3	Lipids: Saturated and unsaturated fatty acids omega 3 and omega 6, simple and complex lipids, terpenes and steroids, phospholipids, biological role of lipids, detergents and soaps, lipids related to food
2	Proteins: Amino acids: structure and configuration, acid-base equilibria of amino acids and peptides, isoelectric point and isoionic, Bond peptide - peptide structures, synthesis of polypeptides, enzymes. Molecules of biological interest.
2	Clinical chemistry and quality control of analytical data

## MODULE BIOCHEMISTRY I

*Prof.ssa ITALIA DI LIEGRO - Sede HYPATIA, - Sede HYPATIA*

### SUGGESTED BIBLIOGRAPHY

1. Butera D., Lauricella M., La chimica organica e le macromolecole biologiche, 2020, Piccin Ed.; ISBN: 978-8829930579;
2. Siliprandi N., Tettamanti G. Biochimica Medica, 2018, Ed. Piccin;
3. Bassi R. et al., Biochimica, 2019, Edi. Ermes.
4. Maccarrone M., Fondamenti di Biochimica Umana, 2021, Ed. Zanichelli
5. Baynes JW., Dominiczack MH. Biochimica per le discipline biomediche, CEA Ambrosiana
6. Devlin T.M. Biochimica con aspetti clinici, Ed. Idelson-Gnocchi
7. Lieberman M, Marks A.D. Biochimica Medica, seconda edizione, Casa Editrice Ambrosiana

Inoltre, di consultazione, per l'approfondimento di aspetti specifici:

1. Berg J.M., Tymoczko J.L., Stryer L. Biochimica, 5a ed. italiana 2003, Zanichelli
2. Nelson D.L., Cox M.M. I Principi di Biochimica di Lehninger, 2018, Zanichelli
3. Garrett R.H., Grisham C.M. Biochimica, Ed. Zanichelli

Nel corso delle lezioni verranno anche fornite fonti bibliografiche specifiche per approfondimenti non presenti nei libri di testo. In addition, a few updated scientific reviews could be suggested on specific topics not covered in the textbook and/or of special interest to the achievement of the educational goals.

<b>AMBIT</b>	50423-Struttura, funzione e metabolismo delle molecole d'interesse biologico
<b>INDIVIDUAL STUDY (Hrs)</b>	90
<b>COURSE ACTIVITY (Hrs)</b>	60

### EDUCATIONAL OBJECTIVES OF THE MODULE

Knowing the biochemical and molecular bases of cellular activities and understanding of the mechanisms that regulate metabolic processes. In particular, the student has to know the biological molecules and the main metabolic processes in which they are involved; knowing and understanding the mode of action of enzymes, the fundamentals of their regulation and catalytic mechanisms, the bases of bioenergetics. The student must already know how to apply his/her knowledge to interpret the behaviour of molecules in biological processes and have the ability to understand the molecular mechanisms underlying metabolic processes of life. Finally, he/she should already have to know the molecular mechanisms of action of chemical messengers and the main modes of extracellular signal transduction.

## SYLLABUS

Hrs	Frontal teaching
3	Structure and composition of biological membranes. Structural models of plasma membrane: fluid mosaic and mosaic of domains. Membrane transport. Osmosis. Simple and facilitated diffusion. Glucose transporters (GLUT). Primary and secondary active transport. Sodium-glucose symporter. Sodium/potassium-dependent ATPase. Calcium transporters. Cardiotonic glycosides.
5	Signal transduction mechanisms. Adenylate cyclase system. Tetanus toxin and cholera toxin. Botulism. Pertussis toxin and diphtheria toxin. Phosphoinositide system. Calcium/calmodulin-dependent systems. Cyclic GMP (cGMP). Membrane- and Cytosolic Guanylate cyclase. Nitric oxide synthase (NOS). The visual cycle: role of vitamin A.
4	Oxygen binding chromoproteins. Myoglobin (Mb). Hemoglobin (Hb). Oxygen transport. Direct and indirect transport of carbon dioxide. Buffer activity of Hb. Hb metabolism. Methemoglobin. Carboxyhemoglobin. Carbaminohemoglobin. Glycated hemoglobin. Atypical hemoglobins. Haemoglobinopathies.
8	Enzymes: general concepts. Mechanisms of enzymatic catalysis. The active site. Specificity. Isozymes. Constitutive and inductive enzymes. Enzymatic kinetics: effect of substrate concentration; effect of enzyme concentration; effect of temperature and pH. Michaelis-Menten Constant: Km. Sequential- and ping-pong- reactions. Cooperative systems: models of Monod and Koshland. Mechanisms of enzymatic inhibition. Enzyme inhibitors in medicine. ACE-inhibitors. Antifolates. Aspirin. Regulation of enzymatic activity. Allosteric regulation. Covalent modifications: phosphorylation, dephosphorylation, ADP-ribosylation. Conversion of zymogens into active enzymes. Plasmatic enzymes in diagnosis. Vitamins: general considerations. Properties and functions of liposoluble and water-soluble vitamins. B1, B6 and B12 vitamins. Folic acids. Metabolism of the monocarbonyl unit.
14	Glucose metabolism: Digestion of polysaccharides and disaccharides; absorption of monosaccharides. Glucose entry into cells and its phosphorylation. Hexokinase and glucokinase. Glycogen metabolism: Glycogenolysis and glycogen synthesis. Blood glucose control. Glycolysis in the presence and absence of oxygen. Gluconeogenesis. Cori cycle. Transfer of reducing equivalents from the cytoplasm to the mitochondria, by the shuttle systems: Glycerol Phosphate Shuttle; malate/ aspartate system. Lactate shuttle. Oxidation of pyruvate. Tricarboxylic acid (TCA) cycle. Pentose phosphate cycle. Metabolism of glucuronic acid. Fructose metabolism. Galactose metabolism. Glycosaminoglycans and proteoglycans. Metabolism of ethanol and its effects on glucose metabolism.

11	Metabolism of lipids. Lipoproteins: general concepts. Fate of chylomicrons. VLDL and their destiny. Receptors for LDL. Atherosclerosis. "Scavenger" receptor. Metabolic use of fatty acids. Albumin. Transport of acyls through the inner membrane of mitochondria: carnitine function. Beta-oxidation of fatty acids. Metabolism of ketone bodies. Ketosis e ketoacidosis. Biosynthesis of fatty acids. Triglyceride metabolism. Metabolism of phospholipids. Cholesterol metabolism: Bile acids and Vitamin D.
3	Oxidative phosphorylation (OXPHOS): electron transport chain and ATP synthesis. Agents that interfere with oxidative phosphorylation. Physiological and non-physiological uncoupling agents. UCPs.
8	Metabolism of amino acids. Essential and non-essential amino acids. Catabolism of the amino acids. Transamination. Oxidative deamination. Decarboxylation. Metabolic fate of ammonia. Glutamate metabolism. GABA. Synthesis and catabolism of glutamine. Synthesis of carbamylphosphate. Urea cycle. Metabolism of methionine and homocysteine. Tryptophan metabolism. Histidine metabolism. Metabolism of phenylalanine and tyrosine. Phenylketonuria, tyrosinosis, alkaptonuria, albinism. Polyamines. Creatine and phosphocreatine: biosynthesis and function.
4	Metabolism of nucleotides. Biosynthesis of purine and pyrimidine nucleotides. Thymidylic Acid biosynthesis. Recovery biosynthesis of nucleotides. Catabolism of purine nucleotides. Metabolism of uric acid. Hyperuricemia. Gout and Lesch-Nyhan syndrome. Ribonucleotide reductase and production of deoxyribonucleotides.

## MODULE BIOCHEMISTRY I

*Prof.ssa MARIANNA LAURICELLA - Sede IPPOCRATE, - Sede IPPOCRATE*

### SUGGESTED BIBLIOGRAPHY

1. Siliprandi N., Tettamanti G. Biochimica Medica, 5a edizione, 2018, > Ed. Piccin, ISBN: 8829927910 ;
  2. Bassi R. et al., Biochimica, 2019, Edi. Ermes; ISBN: 978-88-7051-536-7;
  3. Maccarrone M. Fondamenti di Biochimica Umana, 2021, Ed. Zanichelli; ISBN: 978-88-08-42019-0;
  4. Baynes J.W., Dominiczack M.H. Biochimica per le discipline biomediche, 3a ed.; CEA Ambrosiana; ISBN: 8821425932;
  5. Devlin T.M. Biochimica con aspetti clinici, Ed. Idelson-Gnocchi, 5a edizione, ISBN: 978-88-214-2593-6;
  6. Lieberman M, Marks A.D. Biochimica Medica, 2a edizione, 2010; Casa Editrice Ambrosiana; ISBN: 978-88-08-18217-3.
- Inoltre, di consultazione, per l'approfondimento di aspetti specifici (In addition, for specific aspects of the Course):
1. Berg J.M., Tymoczko J.L., Stryer L. Biochimica, 8a edizione, 2020, Ed. Zanichelli; ISBN: 9788808520289;
  2. Nelson D.L., Cox M.M. I Principi di Biochimica di Lehninger, 7a edizione, 2018, Ed. Zanichelli; ISBN: 978-88-08-92069-0;
  3. Garrett R.H., Grisham C.M. Biochimica, Ed. Zanichelli; 5a edizione, 2014, ISBN: 8829922331.

<b>AMBIT</b>	50423-Struttura, funzione e metabolismo delle molecole d'interesse biologico
<b>INDIVIDUAL STUDY (Hrs)</b>	90
<b>COURSE ACTIVITY (Hrs)</b>	60

### EDUCATIONAL OBJECTIVES OF THE MODULE

Knowing the biochemical and molecular bases of cellular activities and understanding of the mechanisms that regulate metabolic processes. In particular, the student has to know the biological molecules and the main metabolic processes in which they are involved; knowing and understanding the mode of action of enzymes, the fundamentals of their regulation and catalytic mechanisms, the bases of bioenergetics. The student must already know how to apply his/her knowledge to interpret the behavior of molecules in biological processes and have the ability to understand the molecular mechanisms underlying metabolic processes of life. Finally, he/she should already have to know the molecular mechanisms of action of chemical messengers and the main modes of extracellular signal transduction.

## SYLLABUS

Hrs	Frontal teaching
3	Structure and composition of biological membranes. Mosaic Fluid model and mosaic of domains model. Membrane transport. Osmosis Simple and facilitated diffusion. Active transport. Glucose transporters (GLUT). Na <sup>+</sup> -glucose symport. Na <sup>+</sup> /K <sup>+</sup> -dependent ATPase. Ca <sup>++</sup> dependent ATPase. Other transport systems for calcium. Glycosides cardiotoxic
5	Signal transduction mechanisms Adenylate cyclase system. Cholera toxin. Pertussis and diphtheria toxins. Phosphoinositides system. Ca <sup>++</sup> -calmodulin system. Cyclic GMP (cGMP). Membrane and cytosolic guanylate cyclase. Nitric Oxide synthase (NOS). Vision process. Vitamin A. Transducin.
4	Oxygen ligand chromoproteins Myoglobin (Mb) and Haemoglobin (Hb). Oxygen transport. Carbonic anhydride transport. Haemoglobin buffer action. Meta-haemoglobin Carboxy- haemoglobin. Atypical haemoglobins. Haemoglobinopathy.
8	Enzymes Generality. Enzymatic catalysis mechanisms. Active site. Specificity. Iso-enzymes. Constitutive and inducible enzymes. Enzymatic kinetics: influence of substrate concentration, influence of enzyme concentration; Temperature and pH influence. Michaelis-Menten constant. Sequential and ping-pong reactions. Monod and Koshland cooperative systems. Enzymatic inhibition mechanisms. Enzyme inhibitors in medicine. Statins. Anti-folic. Aspirin. Enzymatic activity regulation: Allosteric regulation. Covalent modifications: phosphorylation, ADP-ribosylation PARP. Conversion of zymogen into active enzymes. Vitamin K. Anticoagulants.
14	Carbohydrates metabolism. Digestion of polysaccharides and monosaccharides. Glucose input into the cells. Glucose uptake in the cells. Glucose phosphorylation. Hexokinase and glucokinase. Glycogen Metabolism: Glycogen synthesis and Glycogenolysis Glycolysis in the presence or absence of oxygen. Gluconeogenesis. Cori cycle. Transfer of reductant equivalents from cytoplasm to mitochondria through shuttle systems: phosphodihydroxyacetone/glycerol-3-phosphate system; malate/aspartate system. Pyruvate oxidation. Krebs cycle. Pentose-phosphate cycle. Glucuronic acid metabolism. Fructose metabolism. Galactose metabolism. Glycosaminoglycans



11	<p>Lipid metabolism</p> <p>Lipoproteins: generalità. Kilomicrones destiny . VLDL destiny. LDL receptors. Atherosclerosis. Scavenger receptor. Metabolic utilization of fatty acids. Acyl transfer through inner mitochondrial membrane: carnitine function beta –oxydation of fatty acids. Ketone bodies metabolism Ketosis and Ketoacidosis. Fatty acid biosynthesis. Triglycerides metabolism. Phospholipids metabolism. Cholesterol metabolism. Biliaric acid and Vitamin D.</p>
8	<p>Metabolism of amino acids. Essential and non-essential amino acids. Catabolism of amino acids. Transamination. Oxidative Desamination. Transdesamination. Decarboxylation. Metabolism of ammonia. Glutamate metabolism. GABA. Synthesis and catabolism of glutamine. Synthesis of carbamylphosphate. Urea cycle. Methionine metabolism and homocysteine metabolism. Tryptophan Metabolism. Metabolism of histidine. Metabolism of phenylalanine and tyrosine. Phenylketonuria, tyrosinosis, alcaptonuria, albinism. Polyamines. Creatine and phosphocreatine: biosynthesis and function</p>
3	<p>Oxidative Phosphorylation (OXPHOS): Electron transport chain and ATP synthesis. Agents that interfere with oxidative phosphorylation. Physiological and non-decoupling agents. UCPs</p>
4	<p>Nucleotide metabolism. Purine and pyrimidine nucleotide biosynthesis. Thymidylic acid biosynthesis. Synthesis and recovery. Purinic nucleotides catabolism. Metabolism of uric acid. Hyperuricemia. Gout and Lesh-Nyhan syndrome. Ribonucleotide reductase and production of desoxyribonucleotides.</p>

## MODULE BIOCHEMISTRY I

*Prof.ssa SONIA EMANUELE - Sede CHIRONE, - Sede CHIRONE*

### SUGGESTED BIBLIOGRAPHY

1. Siliprandi N., Tettamanti G. Biochimica Medica, 5a edizione, 2018, Ed. Piccin, ISBN: 8829927910 ;
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<b>AMBIT</b>	50423-Struttura, funzione e metabolismo delle molecole d'interesse biologico
<b>INDIVIDUAL STUDY (Hrs)</b>	90
<b>COURSE ACTIVITY (Hrs)</b>	60

### EDUCATIONAL OBJECTIVES OF THE MODULE

Detailed knowledge of molecules of biologic interest and principal metabolic processes in which they are involved. Knowledge and understanding of enzyme action modality, regulation and catalysis. Knowledge and understanding of bioenergetic basis.

## SYLLABUS

Hrs	Frontal teaching
3	Structure and composition of biological membranes. Fluid mosaic and domain mosaic models. Membrane transport. Osmosis. Simple and facilitated diffusion. Glucose transporters (GLUT). Primary and secondary transport. sodium /glucose symport. Sodium /potassium dependent ATPase. Calcium dependent ATPase. Other transport systems for calcium. Cardiotonic glycosides.
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12	Lipid metabolism Lipoproteins: generalità. Chylomicrons destiny . VLDL destiny. LDL receptors. Atherosclerosis. Scavenger receptor. Metabolic utilization of fatty acids. Acyl transfer through inner mitochondrial membrane: carnitine function beta -oxydation of fatty acids. Ketone bodies metabolism Ketosis and Ketoacidosis. Fatty acid biosynthesis. Triglycerides metabolism. Phospholipids metabolism. Cholesterol metabolism.

8	Amino acids metabolism Essential and no essential amino acids. Amino acids catabolism Transamination. Oxidative deamination. Decarboxylation. Metabolic destiny of ammonia. Glutamate synthesis Glutamine synthesis and demolition. carbamylphosphate synthesis. Urea Cycle. Metionin metabolism. phenilalanine and tyrosine metabolism. Phenylketonuria. Poliammines. Creatin and phosphocreatin: synthesis and function.
2	Oxidative phosphorylation Biologic redox chain. Q coenzyme, cytochromes, ATP synthase. Phosphorylation at the level of substrate.
4	Nucleotide metabolism Purine e pyrimidine nucleotides biosynthesis. timidilic acid biosynthesis. Recovery nucleotides biosynthesis. Purine nucleotide catabolism Alterations of uric acid metaboolism. Hyperuricemia.