# NATIONAL UNIVERSITY OF ENGINEERING
# COLLEGE OF SCIENCES
# CHEMISTRY PROGRAM

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# CQ441 – ORGANIC CHEMISTRY III

## I. GENERAL INFORMATION

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| **CODE** | **:** | CQ441 – Organic Chemistry III |
| **SEMESTER** | **:** | 7 |
| **CREDITS** | **:** | 06 |
| **HOURS PER WEEK** | **:** | 08 (Theory – Practices – Laboratory) |
| **PREREQUISITES** | **:** | Organic Chemistry II |
| **CONDITION** | **:** | Mandatory |

## II. COURSE DESCRIPTION

The course of ORGANIC CHEMISTRY III has a theoretical and practical nature and is aimed at students in the seventh cycle of the chemistry program. Its purpose is to generate critical thinking to argue the reactivity of the main biomolecules. Likewise, to develop the skills to handle reaction systems that will allow the student to develop with sufficiency in later studies, considering the security measures at work.
It comprises five topics: carbohydrates, amino acids and carbohydrates, heterocyclics of five and six members and natural products.

## III. COURSE OUTCOMES

a) Generic Outcomes

By the end this course the student will have the:

- Capacity for abstraction, analysis and synthesis.
- Ability to apply knowledge in practice.
- Ability to organize and plan time.
- Oral and written communication skills.
- Skills to search, process and analyze information from different sources.
- Ability to extract relevant information from scientific articles in Spanish and other languages.
- Ability to identify, formulate and solve problems.
- Capacity for teamwork.
- Commitment to preserving the environment.

b) Specific Outcomes

By the end this course the student will:

- Analyze the structure and reactivity of the most common biomolecules as an application of the chemistry study of oxygenated and nitrogenous functional groups for the synthesis of their derivatives, considering the safety measures at work.

- Correlate the knowledge of the electronic structure of the main types of aromatic heterocycles with its reactivity against reagents of different nature to propose viable reaction mechanisms, respecting the reactivity patterns of the aromatic compounds.

- Apply the knowledge of reactivity of different functional groups to propose the synthesis of different heterocyclic systems.

- Recognize the importance of the chemistry of natural products as a research branch in organic chemistry, important to the country with the use of our natural resources, through the awareness of respect for our environment.

- Apply the main techniques of synthesis, extraction and separation of substances in obtaining organic compounds from a chemical reaction, considering the excessive use of solvents for the care of the environment.

## IV. LEARNING UNITS

### 1. UNIT 1: CARBOHYDRATES

Presentation. Monosaccharides. Definition. Classification. Configuration D and L. Representations. Anomers Mutarotation. Glycosides. Anomeric effect.
Characteristic Reactions. Mechanisms: Formation of acetals. Hydrolysis of acetals. Acetylation Benzylation, tosylation and methylation / Oxidation reaction. Reaction with phenylhydrazine: Osazones formation. Furfural formation: Molisch, Seliwanoff and Bial test. Disaccharides hydrolysis.
Synthesis of several stages involving monosaccharides. Synthesis of ascorbic acid (Vitamin C). Synthesis of the C1-C5 fragment of maytansinoids. Various other syntheses.
Disaccharides, oligosaccharides and polysaccharides.

### 2. UNIT 2: AMINO ACIDS AND PROTEINS

Important compounds. Definitions. Natural and essential amino acids. Structural characteristics. Peptides. Peptide bond. Polypeptides. Nomenclature. Proteins. Reactions of Amino Acids. Reactions of the amino group and the carboxyl group. Protective and activating groups. Synthesis of peptides. Reaction of ninhydrin. Acid-base properties. Dipolar nature. Isoelectric point.
Proteins. General aspects and examples. Structure determination: Protein analysis. Primary, secondary and tertiary structure. Enzymes, hormones Denaturalization.

### 3. UNIT 3: HETEROCYCLIC COMPOUNDS OF FIVE MEMBERS

Characteristics. Definition and examples. Structure of Furan, Pyrrole and Thiophene. Aromaticity. Resonance structures. Reactions of Furan, Pyrrole and Thiophene. Electrophilic aromatic substitution reactions (acylation, alkylation, Vilsmeyer). Examples and reaction mechanisms. Orientation of the substitution. Effect of the substituents on the substitution position.
Furan Synthesis and derivatives. Examples. Reaction Mechanisms. Furan: Feist-Benary Synthesis. Benzofuran. Pirrol Synthesis and derivatives. Examples. Reaction Mechanisms: Paal Knorr. Knorr. Hantzsch.
Indole. Structure and Reactions: Vilsmeyer-Haar. Gatterman Reimer-Tieman. Mannich. Electrophilic Substitution.

Indole Synthesis and derivatives. Examples. Reaction Mechanisms: Fischer. Madelung Reissert. Derivatives of Indole. Structure and Synthesis: Indoxil and Indigotine (indigo). Oxindol and Isatin.
Azoles. Structure and synthesis Pyrazoles and imidazoles. Oxazoles and isoxazoles. Thiazoles Triazoles and Osotraizoles.

4. **UNIT 4: HETEROCYCLIC COMPOUNDS OF SIX MEMBERS**
Important compounds (coumarins, flavonoids). Pyridine. Structure, aromaticity and basicity. Reactions of pyridine and derivatives. Electrophilic substitution reaction. Characteristics. Nucleophilic N – Oxides reaction. Hantszsch synthesis of Pyridine. Quinolein. Synthesis procedures: Skraupp. Friedlander. Conrad - Limpach. Doebner - Miller. Pfitzinger. Isoquinoline. Synthesis procedures: Bischler - Napieralsky. Pictet - Spengler. Pomeranz - Fritsch. Coumarins. Synthesis procedures.

5. **CHAPTER 5: NATURAL PRODUCTS AND ALCALOIDS**
Natural Products Chemistry. Introduction. Definition and classification. Importance of its study. Research Methodology.
Alkaloids. Examples and natural source. Definition and classification. Isolation of alkaloids present in plants. Examples. Alkaloids synthesis: N, N - Dimethyltryptamine. Harmina. Norharman.

## V. LABORATORIES AND PRACTICAL EXPERIENCES

1. Laboratory 1: Carbohydrates - Acetylation of D-glucose and characteristic reactions.
2. Laboratory 2: Amino acids and proteins.
3. Laboratory 3: Natural C-glycosides - Isolation of carminic acid from cochineal.
4. Laboratory 4: Heterocyclic compounds of 5 members.
5. Laboratory 5: 6-member heterocyclic compounds - synthesis of Atophan.
6. Laboratory 6: Natural products

## VI. METHODOLOGY

The course is developed in theory sessions and laboratory practices. In the theoretical sessions the teacher will dictate the classes. Likewise, laboratory practices will be carried out that will complement the theory.
Presents the phenomenon, the concepts, laws and applications. The student will be evaluated continuously through his oral interventions, oral and individual expositions.

## VII. EVALUATION FORMULA

Calculation of the final grade (FG):

$$FG = \frac{1 * PE + 1 * FE + 1 * PA}{3}$$

PE: Partial Exam (Weight 1)
FE: Final Exam. (Weight 1)
PA: Practices Average (Weight 1)

## VIII. BIBLIOGRAPHY


- PAQUETTE, LEO, FUNDAMENTOS DE QUÍMICA HETEROCÍCLICA. ED. LIMUSA, 1992
- TEACHER ANNOTATIONS AND SELECTED SCIENTIFIC ARTICLES.
- TEXTS ABOUT EXPERIMENTAL ORGANIC CHEMISTRY (FURNISS ET AL.-1978, ETC.
- FOR EACH LABORATORY PRACTICE PERTINENT REFERENCES WILL BE GIVEN.