REPUBLIC OF ALGERIA DEMOCRATIC AND POPULAR
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

TRAINING OFFER STATE ENGINEER DEGREE

IN MARINE BIOTECHNOLOGY

Institution	Faculty/Institute	Department
National Higher School of Marine Sciences and Coastal Management (ENSSMAL)		Living Resources

Field: Natural and Life Sciences (SNV)

Stream: Marine and Continental Hydrobiology (HBMC)

Specialization: Marine Biotechnology

Academic Year: 2023-2024

SUMMARY

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

I. Identity Sheet

Institution: ENSSMAL
Program Title: Marine Biotechnology
Academic Year: 2023-2024

1. Program Location

National Higher School of Marine Sciences and Coastal Management (ENSSMAL)

Department: Living Resources

Program Coordinator

Name: BOUKHAROUBA Aya
Position: Associate Professor/Senior Lecturer
Email: aya.boukharouba@enssmal.edu.dz

2. Program Partners

2.1. National Partners

2.1.1. Higher Education Institutions

- University Institutions

• Agreement establishing the National Network of Higher Schools in Natural and Life Sciences:

- ENSSMAL
- National Higher Veterinary School of Algiers (ENSV) - Rabie BOUCHAMA
- National Higher Agronomic School of Algiers (ENSA) - Kasdi MERBAH
- Higher School of Food Sciences and Agrofood Industries (ESSAIA)
- National Higher School of Biotechnology (ENSB) - Taoufik KHAZNADAR
- National Higher School of Forestry (ENSF)
- Higher School of Biological Sciences of Oran (ESSBO)
- Higher Agronomy School of Mostaganem (ESA)
- Partnership agreement with Abou Bakr BELKAID University of Tlemcen
- Partnership agreement with Houari BOUMEDIENE University of Science and Technology (USTHB) (pending signature)
- National Polytechnic School of Algiers
- University of Annaba: Marine Sciences Department
- University of Mostaganem: Marine Sciences Department
- University of Bejaia: Pharmaceutical Sciences Research Center (CRSP)

- Research Centers:

- National Center for Fisheries and Aquaculture Research and Development (CNRDPA)
- Nuclear Research Center of Algiers (CRNA)
- National Waste Agency (AND)
- CEI HALFAOUI
- Technical Training School for Fisheries and Aquaculture of Beni-Saf (EFTPA)
- Algerian Corporate Universities Group (GACU)
- GITRAMA Group (Maritime Works Infrastructure Group)
- National Higher Institute of Fisheries and Aquaculture (INSPA)
- Institute of Fisheries and Aquaculture Technologies (ITPA Collo)
- Maritime Studies Laboratory (LEM)
- Algiers Water and Sanitation Company (SEAAL) (pending signature)
- USTHB Technical Platform
- DP World
- SPA CCS Industry
- NEPHROPS Environmental Engineering
- Fisheries and Halieutic Resources Directorate of Ain Témouchent
- Marine Cultures Company - CULTMARE
- Gouraya National Park
- Association for Research, Information and Underwater Training (RECIF)
- KALYPSO Diving Club
- AQUAMAR Underwater Diving School (pending signature)
- PARADIVE Diving Club

2.1.2. Corporate and Socio-Economic Partners

Partner Organization	Area of Collaboration	Agreement Type
Maritime Studies Laboratory (LEM)	Coastal Engineering	Framework Agreement
GITRAMA	Maritime Works	Framework Agreement
General Directorate of Environment	Marine Environment	Framework Agreement
National Coastal Commission	Coastal Management/Surveillance	Framework Agreement
Algerian Space Agency (ASAL)	Mapping/Remote Sensing	Framework Agreement
CNRDPA (Bou-Ismail)	Fisheries & Aquaculture	Framework Agreement
CNRDB (Algiers)	Maritime Transport	Framework Agreement
SONATRACH Commission	-	Framework Agreement
SAIDAL	Pollution Control Processes & Biocorrosion	Framework Agreement
CRAPC	Pharmaceutical Sector	Framework Agreement
CDER	Analysis Methods	Framework Agreement
Taza National Park (Jijel)	Protected Area	Framework Agreement
PN Grands Vents (Algiers)	Protected Area	Framework Agreement
PN Gouraya	Protected Area	Framework Agreement

Partner Organization	Area of Collaboration	Agreement Type
PN (Béjaia)	Protected Area	Framework Agreement
National Coastal (Algiers)	Protected Area	Framework Agreement
Ain Benian Analysis Laboratory	Quality Control	Framework Agreement
National Coastal Commission (Algiers)	Wastewater Treatment & Sludge Valorization	Framework Agreement
National Sanitation Office	Wastewater Treatment & Sludge Valorization	Framework Agreement
-	Human/Veterinary Health & Pharmaceutical Biotechnology	Framework Agreement
Pasteur Institute of Algeria	Human/Veterinary Health & Pharmaceutical Sector	Framework

2.2. International Partners

- Istanbul University (Turkey)
- Ankara University (Turkey)
- Akdeniz University (Antalya, Turkey)
- International Maritime University (France)
- Nouakchott Al Aasria University (Mauritania)

3. Context and Objectives of the Program

A. Access Conditions

The program is intended for:

Students admitted through the national competitive exam (integrated preparatory classes of ENSSMAL, preparatory classes in the fields: STU and SNV) who meet the minimum required average for admission to the specialization.

B. Training Objectives

According to the Organization for Economic Co-operation and Development (OECD), biotechnology is defined as "the application of scientific and engineering principles to the processing of materials by biological agents to produce goods and services."

Marine biotechnology (blue biotechnology) involves either: The use of biotechnological processes to bio-convert or bio-preserve marine resources, or the application of whole or partial marine organisms to materials of diverse origins.

Indeed, macroalgae, microalgae, halophilic plants, microorganisms, marine animals, and byproducts offer significant potential in terms of valuable biomolecules for a wide range of applications and markets: - Health, agriculture, agri-food, aquaculture - Nutraceuticals, pet food, cosmetics, fine chemicals - Environmental protection, etc.

Mission of the Marine Biotechnology Engineer: The role of a marine biotechnology engineer is to sustainably exploit and valorize marine biodiversity through biotechnology and bio-prospecting, while contributing to the optimized use of products and byproducts from fishing and aquaculture.

Their responsibilities also include: Biosurveillance of marine and coastal environments through diagnostics and molecular analyses (e.g., studying pollutant behavior in marine ecosystems and identifying early biomarkers). Implementing bioprocesses for pollution control and bioremediation.

Additionally, the program covers business management, marketing, and entrepreneurship, making it a professionally oriented training.

C. Profiles and Targeted Professional Skills

<u>Specific Skills</u>

✓ Ability to adopt an integrated approach to the valorization of marine-derived biomass.

✓ Capable of conducting fieldwork (sampling at sea) and laboratory work (identification, extraction, purification, and characterization of marine products and byproducts).

✓ Ability to lead and manage a multidisciplinary research and development (R&D) team.

✓ Participate in the design and development of new products, services, or processes as part of an innovation project within a private company or in response to national and international calls for proposals.

✓ Conduct monitoring activities (patent watch, technological, regulatory, and competitive intelligence) to identify new scientific trends and guide strategic thinking.

✓ Lead and supervise an R&D team within private-sector organizations.

✓ Provide expertise and consulting services to public and private institutions.

✓ Ability to take on administrative and managerial roles, particularly in supervising technical staff.

✓ Understand the general functioning of a company.

Transferable Skills

✓ Master the methods required for the biotechnological valorization of biological resources, applicable across various fields.

✓ Proficient in engineering approaches, methods, and tools.

✓ Knowledge of regulatory frameworks governing the production and marketing of biotech products.

✓ Fluency in English to work in an international context and communicate effectively with clients, suppliers, equipment manufacturers, and commercial/marketing teams.

D. Regional and National Employability Potential Graduates

Graduates of ENSSMAL (Marine Biotechnology Engineers) have strong prospects for employment in national economic sectors.

This professional training program opens doors to a wide range of career opportunities. Engineers can work in:

Private companies (nationally or internationally), Applied research, Technology transfer structures, and Professional organizations involved in the processing and valorization of marine products (Technoparks, Competitiveness Clusters, etc.).

Additionally, marine biotechnology engineers can work in three major industry sectors:

✓ Chemical Industry – Developing eco-friendly alternatives to petrochemical processes (Green Chemistry), such as: Biofuel production (biodiesel, bioethanol); Bioplastics, etc.

✓ Pharmaceutical & Cosmetic Industries – Utilizing marine biomolecules as active ingredients in: Drugs (Biopharma, Saidal, Hikma, Mérinal, Phytopharma, Magpharma, El Kendi, Sanofi Pasteur, etc.); Skincare products, face treatments, and thalassotherapy.

✓ Food Industry – Producing: Food additives (pigments, alginates); Nutritional supplements and functional foods.

Employment Opportunities in Research Institutes & Development Centers

(CRBT, CNRDPA, CDER, INRA, CRNA, CNRD, etc.)

Graduates can pursue roles such as:

- R&D Assistant or Manager
- Production Manager, Site/Unit Supervisor (e.g., SAIDAL, SONATRACH)
- Project Manager, Expert, Consultant, Corporate Trainer
- Technical Sales Manager (e.g., in water treatment units – SEAAL, ONA)
- Production roles in biotech industries
- Microbiological & physicochemical control laboratories
- Universities & academic research
- Private SMEs/SMIs, with opportunities to launch new startups and entrepreneurial ventures.

Finally, a growing number of young engineers are innovating and launching their own startups in various biotechnology fields, including:

- Pharmaceuticals
- Cosmetics
- Agri-food
- Environmental biotechnology
- Bio-industry & bioenergy
- Animal production
- Biomass treatment and valorization
- Further Studies

Graduates may also pursue a PhD for advanced research and academic careers.

E. Pathway to Other Specializations

The program aims to train engineers in marine bioresources and biotechnology applications for:

- Human and animal health
- Food processing
- Industrial applications
- Environmental management
- Renewable energy
- Students may continue their higher education in natural and life sciences fields.

F. Program Monitoring Indicators

To ensure proper functioning of the modular system and integration, a Coordinating Pedagogical Committee will be established for each semester and each training profile. This committee will:

- Monitor student progress throughout the semester
- Meet weekly during the first three weeks, then at least every three weeks thereafter
- Produce meeting minutes documenting decisions and proposals to be shared with the department and administration

A schedule will be established at the beginning of each semester/year to plan subcommittee meetings and schedule full committee sessions.

Module implementation requires coordination between module leaders and teaching assistants responsible for tutorials and practical work

Finally, at program completion, students will present their graduation thesis before an evaluation committee, receive final assessment of their work then be evaluated for program completion.

G. Supervision Capacity

Maximum cohort size: 30 students. G.

4. Available Human Resources

Nom Prénom	Diplôme	Grade	Type d'intervention	Emargement
M. Grimes Samir	Doctorat d'état	Prof.	Enseignement/Encadrement	
M. Kacher Mohamed	Doctorat	Prof.	Enseignement/Encadrement	
M. Refes Wahid	Doctorat d'état	Prof.	Enseignement/Encadrement	
M. Boulahdid Mostafa	Doctorat d'état	Prof.	Enseignement/Encadrement	
Mme Bachari Houma	Doctorat d'état	Prof.	Enseignement/Encadrement	
Mme Ait Aissa Djamila	Doctorat d'état	MCA	Enseignement/Encadrement	
Mme Aissou Cherifa	Doctorat	MCA	Enseignement/Encadrement	
Mme Alouache Souhila	Doctorat d'état	MCA	Enseignement/Encadrement	
Mme Boufersaoui Samira	Doctorat	MCA	Enseignement/Encadrement	
Mme Ould Ahmed Nora	Doctorat d'état	MCA	Enseignement/Encadrement	
Mme Ghazi Malika	Doctorat	MCA	Enseignement/Encadrement	
Mme Boughamou Naima	Doctorat	MCA	Enseignement/Encadrement	
Mme Boumaza Salima	Doctorat	MCB	Enseignement/Encadrement	
Mme Benzouai Sihem	Doctorat	MCB	Enseignement/Encadrement	
Mme Keraghel Mahdia	Doctorat	MCB	Enseignement/Encadrement	
M. Ait Saidi Adel	Doctorat	MCB	Enseignement/Encadrement	
M. Laouedj Abdessalem	Doctorat	MCB	Enseignement/Encadrement	
Mme Mokhbi Dehbia	Doctorat	MCB	Enseignement/Encadrement	
Mme Abdedaim Hakima	Doctorat	MCB	Enseignement/Encadrement	

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Specialization: Marine Biotechnology

Mme Bahbah	Doctorat	MCB	Enseignement/Encadrement	
Mme Boumaour Amina	Doctorat	MCB	Enseignement/Encadrement	
Mme Djahnit Nora	Doctorat	MCB	Enseignement/Encadrement	
Mme Maouel Djamila	Doctorat	MCB	Enseignement/Encadrement	
Mme Khelifa Nedjma	Doctorat	MCB	Enseignement/Encadrement	
Mme Amar Imen	Magister	MAA	Enseignement/Encadrement	
Mme Amrouche Lynda	Magister	MAA	Enseignement/Encadrement	
Mme Bourabaine Fouzia	Magister	MAA	Enseignement/Encadrement	
Mme Chaou Nadia	Magister	MAA	Enseignement/Encadrement	
Mme Ghalmi Rachida	Magister	MAA	Enseignement/Encadrement	
M. Kabrane Amine	Magister	MAA	Enseignement/Encadrement	
M. Bouaicha Farid	Magister	MAA	Enseignement/Encadrement	
M. Kada Mohamed	Magister	MAA	Enseignement/Encadrement	
M. Boughrira Abdelhak	Magister	MAA	Enseignement/Encadrement	
Mme Kaïdi Nawal	Magister	MAA	Enseignement/Encadrement	
M. Kassar Abderrahmane	Magister	MAA	Enseignement/Encadrement	
Mme Ladoul Sara	Magister	MAA	Enseignement/Encadrement	
Mme Lahmer Nahla	Magister	MAA	Enseignement/Encadrement	
M. Zeghache Abdelkader	Magister	MAA	Enseignement/Encadrement	
Mme Mouzali Leila	Magister	MAA	Enseignement/Encadrement	

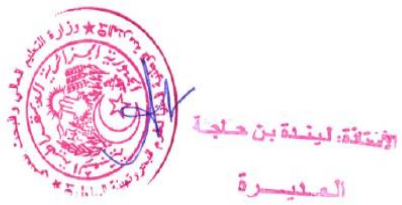
Visa du département

Visa de l'établissement

b- Encadrement externe :

Nom Prénom	Diplôme / spécialité	Grade	Type d'intervention	Etablissement de rattachement
Mme BENHADJI Amel	Génie des Procédés	MCA	Encadrement, conférences , cours	USTHB
Mme LARIBI Hassiba	Génie de l'environnement	Pr	Cours, encadrement	U. Blida
Mme BOUANANE Amel	Microbiologie	Pr	Cours, encadrement	USTHB
Mme ARBIA Wassila	Génie de l'environnement/ Biotechnologie	MCA	Cours, encadrement	U. MEDEA
Mme Chekir Nadia	Génie des Procédés	MAA	Encadrement, cours	USTHB
Mme Mansour Dalila	Environnement	Docteur	Encadrement, cours	Sonatrch
Mme. Gacem Fatiha	Microbiologie	MCA	Encadrement,Conférence	IPA
M. CHADER Henni	Toxicologie- pharmacologie	Pr	Encadrement,Conférence	IPA
M. Bensouici Chawki	Biochimie- immunologie	MCA	Encadrement,Conférence	CRBT/Constantine
M. Igoud Sadek	Environnement /énergie renouvelable	Pr	Encadrement,Conférence	UDES/Busmail
Mme AAMI	Toxicologie- pharmacologie	Docteur	Encadrement	ANPP
Mme Halladj Fatima	Microbiologie	MCB	Encadrement	U. Boumerdes
Mme ALAMIR Hanane	Microbiologie alimentaire	Docteur	Encadrement, Conférence	IPA

Visa du département **Visa de l'établissement**



5. Available Specific Material Resources

A. Teaching Laboratories and Equipment

Technical Platform – Analytical Methods Laboratory

No.	Equipment & Brand/Model	Quantity
1	Atomic Absorption Spectrometer (AAS) Perkin Elmer – PinAAcle 900H	1
2	High-Performance Liquid Chromatograph (HPLC) Perkin Elmer – Altus A-10	1
3	Ion Chromatograph Shimadzu	1
4	Gas Chromatograph (GC) Shimadzu	1
5	Water Circulation Chiller LAUDA – MC600	1
6	Freeze Dryer (4 shelves, 250mm diameter)	1
7	Hydrogen Generator HyGen 600	1
8	Nitrogen/Air Generator NitroAir	1
9	Water Distiller	1
10	Oven Binder	1
11	Chemical Fume Hood	1

Equipment –coastal engineering Laboratory

No.	Equipment & Brand/Model	Quantity
1	Calcimetry Apparatus Soil Analysis	1
2	Casagrande Apparatus (Atterberg Limits) Geotechnical Testing ELE International	1
3	Sand Equivalent Test Apparatus Soil Gradation Analysis MATEST (S158-13)	1
4	Precision Balance Weighing (0.001g–220g) OHAUS (CD-11)	1
5	Analytical Balance High-Precision Weighing OHAUS (Adventurer)	1
6	Van Veen Grab Sampler (Medium) Marine Sediment Sampling HYDRO-BIOS	1
7	Van Veen Grab Sampler (Small) Coastal Benthic Sampling HYDRO-BIOS	1
8	Centesimal Comparator Dimensional Measurement BORLETTI (SC 25)	1
9	Conductivity Meter with Probe Water Quality Analysis JENWAY (4071)	1
10	Portable Ice Chest (42L) Sample Storage Campos	1
11	Current Meter Flow Velocity Measurement GLOBAL Water (FP101)	1
12	Drying Oven Sample Drying ProLabo / Jeulin / Memmert	3
13	Binocular Magnifier Microscopic Observation Optech (LFZ)	2
14	Lux Meter Light Intensity Measurement PHYWE (7137)	1
15	Manometers Pressure Measurement	2
16	Geological Hammers Field Sampling ESTWING	14
17	Optical Microscope Biological Analysis Euromax	1

Cell and Molecular Biology Laboratory 1 - Equipment Inventory

No.	Equipment Description	Type	Quantity	Brand/Model
1	Magnetic/Heating Stirrer	Stirring & Heating	1	Labtech
2	Magnetic/Heating Stirrer	Stirring & Heating	1	Labtech
3	Magnetic Stirrer	Stirring	1	IKA Werke
4	Temperature-Controlled BOD Cabinet	Incubation	2	-
5	Autoclave	Sterilization	1	Sano Clave
6	Water Bath	Temperature Control	1	Memmert
7	Precision Balance	Weighing (High Accuracy)	1	OHAUS
8	Precision Balance	Weighing (High Accuracy)	1	OHAUS
9	Bunsen Burner	Heating	32	-
10	Freezer (-20 °C)	Sample Storage	1	Whirlpool
11	BOD Meter	Biochemical Oxygen Demand	12	VELP
12	Universal Oven	Drying/Heating	1	Memmert
13	Bacteriological Oven (30 °C)	Microbial Culture	1	Memmert
14	Bacteriological Oven (37 °C)	Microbial Culture	1	Memmert
15	Bacteriological Oven (44 °C)	Microbial Culture	1	EN500
16	Bacteriological Oven (44 °C)	Microbial Culture	1	Binder
17	Fume Hood	Ventilation	1	TMLab
18	Binocular Loupes	Magnification	10	Motic
19	Optical Microscope	Microscopy	10	Optika
20	Zeiss Microscope	Advanced Microscopy	1	Carl Zeiss (Axio)
21	Micropipettes (1 mL)	Liquid Handling	1	-
22	Micropipettes (0.1 mL)	Precision Liquid Handling	2	-
23	Micropipettes (0.01 mL)	High-Precision Liquid Handling	2	-
24	pH Meter	Acidity Measurement	1	HANNA
25	Vacuum Pump	Filtration	1	Vacuum Pump
26	Vacuum Pump	Filtration	1	Millipore
27	Filtration Rack (6-position, 250 mL)	Sterile Filtration	1	Sartorium
28	Filtration Rack (6-position, 500 mL)	Large-Scale Filtration	1	Sartorium
29	Refrigerator	Sample Storage	1	Condor
30	Vortex Mixer	Sample Mixing	1	Daihan
31	Vortex Mixer	Sample Mixing	1	Iso Lab
32	Propipettes	Liquid Transfer	4	-

Cell and Molecular Biology Laboratory 2 - Equipment Inventory

No.	Equipment Description	Type	Quantity	Brand/Model
1	Magnetic/Heating Stirrer	Mixing & Temperature Control	1	Stuart
2	Magnetic/Heating Stirrer	Mixing & Temperature Control	1	IKA
3	Desiccator Cabinet	Moisture-free storage	1	SICCO
4	Sand Bath	Uniform heating	1	Prolabo
5	Water Bath	Temperature control	1	Memmert
6	Bunsen Burners	Sterilization	16	-
7	Precision Balance (0.001g-220g)	Micro-weighing	1	Shimadzu
8	Laboratory Balance (5kg capacity)	Macro-weighing	1	OHAUS
9	Dissection Kits	Specimen handling	2	OHAUS
10	Flask Heater	Solution heating	1	-
11	Refrigerated Centrifuge (Mid-range)	Cell/organelle separation	1	NF 400
12	High-Speed Centrifuge + Accessories	Ultracentrifugation	1	Sigma 3K30
13	Microcentrifuge	Small-volume spinning	1	Sigma 1-6p
14	Kjeldahl Distillation Unit	Nitrogen analysis	1	Behr
15	Solvent/Acid Dispenser	Precise liquid delivery	1	Socorex
16	Antibiotic Disk Dispenser	Microbiology applications	1	BBL
17	Horizontal Electrophoresis Systems	DNA/RNA separation	2	Sony/Fisher Bioblock
18	TLC Plate Spreader	Chromatography	1	-
19	High-Temp Oven (250°C)	Dry sterilization	1	Memmert
20	Bacteriological Incubator (37°C)	Microbial culture	1	Memmert
21	Soxhlet Extractor (4-station)	Continuous extraction	1	Behr Labortechnik

22	pH Electrode	Acidity measurement	1	SENTIX
23	Electrophoresis Power Supply	Nucleic acid separation	1	Consort
24	Fume Hood	Ventilation	1	OLab Tech
25	Kjeldahl Digestion Unit	Protein nitrogen analysis	1	Behr
26	Micropipette Sets	Precision liquid handling	6	Microline/Transferpette/Exacta
27	Benchtop Microcentrifuge	Small-volume processing	1	Fisher Brand
28	Spectrophotometer Workstation	Optical density measurement	1	-
29	pH Meter	Solution pH measurement	1	Inolab
30	Hot Plate	Solution heating	1	-
31	Polarimeter	Optical activity measurement	1	Millipore
32	Vacuum Pump	Filtration/Solvent Evaporation	1	-
33	Vacuum Pump	General laboratory use	1	-
34	Portable Refractometer	Concentration measurement	1	Link
35	Digital Refractometer	Brix/RI measurement	1	Condor
36	Laboratory Refrigerator	4°C storage	1	Huber
37	Recirculating Chiller	Cooling system	1	Buchi R-210
38	Rotary Evaporator	Solvent recovery	1	IKA
39	Rotary Evaporator	Solvent removal	1	Shimadzu 1800
40	UV-Vis Spectrophotometer	Quantitative analysis	1	Millipore
41	Glass Filtration Unit (Single)	Sterile filtration	1	-
42	Stainless Steel Filter (Single)	Chemical filtration	1	-
43	Stainless Steel Filter (Triple)	High-throughput filtration	1	Techne 5Prime
44	Thermal Cycler	DNA amplification	1	-
45	UV Transilluminator Table	Gel visualization	1	-
46	Polarimeter Tube (100mm path)	Optical rotation	1	-

47	Polarimeter Tube (200mm path)	Low-concentration analysis	1	HANNA
48	Digital Thermometer	Precision temperature	1	

Cell and Molecular Biology Laboratory 3 - Equipment Inventory

No.	Equipment Description	Type	Quantity	Brand/Model
1	Vortex Mixer	Sample homogenization	1	IKA
2	Chemical Storage Cabinet	Hazardous material storage	1	-
3	Autoclave	Sterilization	1	Isolab
4	Stainless Steel Tank	Sample processing	1	-
5	Analytical Balance	Precision weighing	1	KERN
6	Benzene Burners	Sterilization	8	-
7	Centrifuge	Cell separation	1	SIGMA
8	Drying Oven	Dehydration	1	NÜVE
9	Chemical Fume Hood	Ventilation	1	ASEM
10	Wooden Fish Measuring Boards	Ichthyology	4	-
11	Micropipette Set (10-50µL)	Liquid handling	1	SINNOWA
12	Compound Microscopes	Cellular imaging	10	MOTIC
13	Research Microscopes	Advanced imaging	4	Leitz
14	Laboratory Clamps	Apparatus support	7	-
15	Hot Plates	Solution heating	1	BIBBY
16	Hot Plates	Solution heating	1	HARRY GESTIGKEIT
17	Hot Plates	Solution heating	1	HARRY GESTIGKEIT
18	Bulb Pipette Controllers (25 mL)	Liquid transfer	2	-
19	Burette Stands	Titration support	10	-

Chemistry/Physics Laboratory 1 - Equipment Inventory

No.	Equipment Description	Type	Quantity	Brand/Model
1	Magnetic Hotplate Stirrer	CB162	1	STUART
2	Magnetic Hotplate Stirrer	F20500162	1	VELP SCIENTIFICA
3	Acid/Base Storage Cabinet	Ventilated	1	-
4	Precision Balance	ABS 220-4N	1	KERN
5	Magnetic Stir Bars	Various sizes	8	-
6	Single-Position Flask Heater	655	1	NAHITA
7	COD Reactor (6-position)	DCO10119	1	FICHER
8	COD Digestor (6-position)	ECO6	1	VELP SCIENTIFICA
9	Desiccator	Glass	1	-

10	Water Distiller	Puranity TU 6	1	VWR
11	Drying Oven	UN55	1	MEMMERT
12	Fume Hood	SPL	1	ASEM
13	Gas Mask	Multi-gas	1	-
14	Overhead Stirrer	RW20.N	1	KIKA
15	Porcelain Mortars	Various sizes	5	-
16	Metal Tongs	Crucible handling	2	-
17	Hot Plate	HB110	1	LHG
18	Vacuum Pump	NO26.1.2AN.18	1	KNF
19	Pipette Bulbs (20mL)	Rubber	7	-
20	Pipette Bulbs (25mL)	Rubber	2	-
21	Laboratory Refrigerator	HS-208F	1	MIDEA
22	UV-Vis Spectrophotometer	2120UV	1	OPTIZEN
23	Mercury Thermometers	-30 to 300°C	4	-
24	Ultrasonic Cleaner	2510	1	BRANSON

Chemistry / Pollution Laboratory Equipment

No.	Equipment Description	Type	Quantity
1	Separatory funnel agitator (6 stations)	Agitlec	1
2	Balance	Kern	1
3	Centrifuge	Sigma	1
4	Single-round bottom flask heater	Nahita	1
5	3-station round bottom flask heater	BI	1
6	3-station round bottom flask heater	BI	1
7	Single-round bottom flask heater	Nahita	1
8	Conductivity meter	Hanna Instruments EC214	3
9	Benchtop conductivity meter	WTW Inolab 1103	1
10	Benchtop conductivity meter	WTW Inolab	1
11	Conductivity meter	Hanna	2
12	Porcelain crucible with lid	Porcelain	12
13	Desiccator	-	1
14	Distillation unit (includes 1x 6-station flask heater, 6x 250ml flat-bottom flasks, 6x condensers, 6x Vigreux columns)	Wisetherme	1
15	Incubator oven	Memmert UM600	1
16	Flame photometer	Jenway	1
17	Muffle furnace	FH05080318001	1
18	Muffle furnace	Wise Therm	1
19	Micropipettes (100–1000µl)	Bio-Control	3
20	Micropipettes (10–100µl)	Bio-Control	0
21	Micropipettes (5–50µl)	Bio-Control	3
22	Micropipettes (100–1000µl)	Smart	0
23	Porcelain mortar	-	0
24	Benchtop oxygen meter	WTW Inolab	1

25	pH meter	Hanna	1
26	Tongs	-	5
27	Heating plate	GM	1
28	Magnetic hotplate stirrer	Fisher	1
29	Magnetic hotplate stirrer	KIKAmag Werke	1
30	Magnetic hotplate stirrer	Stuart	2
31	Vacuum pump	KNF Neuberger Pmax No 22AN18	1
32	Plastic test tube racks	-	0
33	Stainless steel test tube racks	-	4
34	Filtration station with collection basin	Nalgene	1
35	Propipettes (25ml)	Pobel	1
36	Propipettes (10ml)	Pobel	6
37	3-station stainless steel filtration rack	-	1
38	Plastic filtration rack	-	1
39	COD reactor (6 stations, includes 5 condensers, 6 COD reactor tubes)	VELP Scientifica	1
40	Refrigerator	Condor RDC 450	1
41	Stainless steel spatulas	-	6
42	Laboratory spectrophotometer with accessories	-	1
43	UV-Visible spectrophotometer	Shimadzu	1
44	Metal stand with base	-	2
45	Digital thermometer	Hanna	1
46	Benchtop turbidimeter	Hanna	1
47	Vortex mixer	Fisher TopMix	1

Marine Biology Laboratory 1 Equipment

No.	Equipment Description & Type	Quantity
1	Histological needle (sharp)	9
2	Histological needle (arrowhead)	8
3	Histological needle (60°)	6
4	Stainless steel trays	6
5	Plastic trays	4
6	Scalpel handles (stainless steel)	11
7	Scissors (size 10)	12
8	Whirlpool freezer	1
9	Freezer	1
10	Stainless steel cart	1
11	Microscope slides	100
12	Eyepiece lenses	31
13	Graduated microscope lenses	18
14	Blue filter lenses	21
15	Blue/white filter lenses	10
16	Motic magnifying loupes	5

17	Motic magnifying loupes (high-power)	5
18	Optech magnifying loupes	2
19	Cork stoppers	11
20	Lab goggles	1
21	Zeiss camera microscope	1
22	Zeiss microscopes	9
23	Euromax microscopes	10
24	Uninterruptible power supplies (UPS)	2
25	Manual calipers (Mitutoyo)	4
26	Magnifier plates (black plastic background)	27
27	Magnifier plates (white plastic background)	20
28	Magnifier plates (clear glass)	7
29	Forceps	14
30	Scissors-style forceps	1
31	Plastic wash bottles	11
32	Probes	4
33	Spatulas	2
34	Watch glasses	12

Marine Biology Laboratory 2 Equipment

No.	Equipment Description	Type	Quantity
1	Histological needle (straight, lancet-type)	-	10
2	Histological needle (straight)	-	8
3	Dissection tray	-	1
4	Surgical scissors	-	5
5	Stainless steel scissors	-	7
6	Whirlpool Infiniti freezer	Whirlpool	1
7	Condor freezer	Condor	1
8	Prepared slides	-	134
9	Microscope slides	-	42
10	Binocular magnifying loupes	Motic	12
11	Safety goggles	-	1
12	Eyepiece micrometer (OPTIKA M-005, type 1)	OPTIKA	1
13	Eyepiece micrometer (OPTIKA M-005, type 2)	OPTIKA	1
14	Microscopes	Zeiss	4
15	Microscopes	Optika	5
16	Microscopes	Bioblue	4
17	Microscopes	Optech	1
18	Microscopes	Hund H60	1
19	Manual calipers	Mitutoyo	4
20	Fine-tip forceps	-	18
21	Kocher forceps	-	1
22	Cork dissection boards	-	14
23	Stainless steel trays	-	9
24	Plastic trays	-	2

25	Overhead projector	-	1
26	Stainless steel scalpels	-	9
27	Probes	-	3

Marine Biology Laboratory 3 Equipment

No.	Equipment Description	Type	Quantity
1	Fine straight dissection needles	-	11
2	Lancet-type dissection needles	-	10
3	Stainless steel trays	-	6
4	Standard dissection scissors	-	15
5	Drawer freezer	-	1
6	Binocular magnifying loupes	-	20
7	Scalpel handles	-	17
8	Microscopes	-	20
9	Microscopes (Axio, without camera)	Zeiss Axio	1
10	Manual calipers	-	4
11	Kocher forceps	-	3
12	Curved dissection forceps	-	5
13	Flat-tip dissection forceps	-	20
14	Fine-tip dissection forceps	-	13
15	Wash bottles	-	5
16	Reversible loupe plates (black/white)	-	2
17	Transparent loupe plates	-	5
18	Grooved probes	-	3
19	Dissection kit	-	1
20	Watch glasses	-	6

B. Internship Sites and In-Company Training

Fieldwork and Practical Training:

Practical sessions will include field trips to fishing ports, fisheries, coastal areas, and offshore locations for prospecting and sampling marine bioresources with biotechnological potential.

- 10-Day Training (Working Days):

Scuba Diving Certification (P1): A socially enriching activity that promotes physical well-being and work-life balance, essential for student success.

Alternative Program: For students unable to participate in diving (due to health or other reasons), coastal field trips (fishing ports, fisheries) and an aquariology course will be provided (see program details on page 68).

- Workshop: Digital imaging and artificial intelligence.

21-Day Internship (Working Days):

Professional immersion in companies, research centers, or related organizations to facilitate career integration.

Entrepreneurship Internship:

Hosted at "Blue Start", Algeria's first marine and coastal-focused incubator, supporting innovative projects in marine-related fields. This intensive, customized training leverages national and international expertise and utilizes ENSSMAL's dedicated facilities, including Blue Start's infrastructure and partner resources.

6-Month Final Project Internship:

Conducted as part of the graduation thesis.

C. Research Laboratories Supporting the Training

ENSSMAL's scientific research is structured around two national laboratories:

- Laboratory for Conservation and Valorization of Marine Resources (LCVRM)
- Laboratory of Marine and Coastal Ecosystems (ECOSYSMarL)

These complementary labs aim to organize and advance scientific research under ENSSMAL's academic and training programs.

D. Doctoral Training and Research Support for Master's Programs

ENSSMAL offers third-cycle doctoral programs (LMD and D98 degrees). Key programs include:

- Marine and Continental Hydrobiology (2021–2022)
- Marine and Coastal Environment (2016–2017)

Research focus:
  - Marine Environment
  - Marine & Coastal Geosciences

- Exploitation of Ichthyological Resources (2015–2016)

Research focus:
  - Fisheries Resource Management
  - Aquaculture & Marine Biotechnology

- Doctorate in Marine Sciences (D98)

PRFU Research Projects at ENSSMAL Since 2018

No	PRFU Code	Duration	Project Leader	Title
1	D00L03ES160920180004	2018-2021	Boulahdid M.	Study of pollution and water fertility along Algeria's central coasts
2	D00L03ES160920180003	2018-2021	Refes W.	Spatiotemporal modeling of invasive marine species distribution along the Algerian coast
3	D00L03ES160920180002	2018-2021	Alouache S.	Aquatic microorganisms for biotechnological applications
4	D00L03ES160920190001	2019-2022	Semroud R.	Posidonia oceanica seagrass beds as tools for Algiers coastal biomonitoring
5	D00L03ES160920200002	2020-2023	Hemida F.	Systemic management of halieutic resources
6	D00L03ES160920200001	2020-2023	Bachari F.	Environmental impact monitoring and valorization: Methodological and normative approach
7	D00L03ES160920220001	2022-2025	Refes W.	Evaluation of breeding performance of different Artemia salina strains identified in Algeria
8	D00L03ES160920220002	2022-2025	Boulahdid M.	Study of Pollution and Eutrophication in the Waters of Algeria's Central Coasts

E. Personal Workspaces and ICT Facilities

ENSSMAL provides:

A large library, screening room, multimedia room, four computer labs, and a video-conferencing hall.

ENSSMAL Digital Library: A virtual repository offering remote access to scientific and technical documents for students, graduates, professors, and researchers.

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

II. Semester Course Organization Sheet

Institution: ENSSMAL
Program Title: Marine Biotechnology
Academic Year: 2023-2024

1. Semester 1

Teaching Unit	SHV Semesterly Hourly Volume	Weekly Hourly Volume				Coeff	Credit	Assessment Method	
	14-16 Week	L Lectures	GS Guided Study	PW Practical Work	Other			Continuous Assessment	Exam
Fundamental Teaching Unit									
FTU 1 : Marine Ecology & Pollution									
Course 1 : Marine Ecology	67.5	1h30	1h30	1h30		3	6	50%	50%
Course 2 : Pollution at Land-Sea Interfaces	45	1h30		1h30		2	4	50%	50%
FTU 2 : Molecular Biology & Systematics of Marine Microorganisms									
Course 3 : Molecular Biology	45	1h30	1h30			2	4	50%	50%
Course 4 : Diversity & Systematics of Marine Microorganisms	45	1h30		1h30		2	4	50%	50%
Methodology Teaching Unit									
MTU(O/P) : Techniques d'analyses									
Course 1 : Instrumental Analysis Techniques	67.5	1h30	1h30	1h30		3	5	50%	50%
Course 2 : Biostatistics	45	1h30	1h30	-		2	3	50%	50%
MTU 2 (O/P) : Heat & Mass Transfer									
Course 4 : Heat & Mass Transfer	45	1h30	1h30	-		2	3	50%	50%
Transversal Teaching Unit									
TTU 1 (O/P)									
Course 1 : English*	15*	1h30	-	-		1	1	50%	50%
Total Semester 1	375								

*: For 10 weeks of teaching.

1. Semester 2

Teaching Unit	SHV	Weekly Hourly Volume				Coeff	Credit	Assessment Method	
	14-16 Week	L	GS	PW	Other			Continuous Assessment	Exam
Fundamental Teaching Unit									
FTU 1 : Systématique des organismes marins									
Course 1 : Systematics of Marine Plants	45	1h30		1h30		2	4	50%	50%
Course 2 : Systematics of Marine Invertebrates	37.5	1h30		1h		2	4	50%	50%
Course 3 : Systematics of Marine Vertebrates	30	1h30		30mn		1	2	50%	50%
FTU 2 : Marine Ecophysiology and Cell Signaling									
Course 1 : Marine Physiology and Ecophysiology	45	1h30	45mn	45mn		2	4	50%	50%
Course 2 : Cell Communication and Signaling	45	1h30	1h30			2	4	50%	50%
Methodology Teaching Unit									
MTU (O/P) : Multidimensional Analyses and Digital Imaging									
Course 1 : Multidimensional Data Analysis (MDA)	45	1h30	1h30			2	3	50%	50%
Course 2 : Workshop 1 (Digital Imaging)	37.5				37.5	2	3	50%	50%
MTU (O/P) : Génie génétique									
Course 1 : Genetic Engineering	45	1h30	45mn	45mn		2	4	50%	50%
Transversal Teaching Unit									
TTU (O/P) : Literature Research and Communication									
Course 1 : Literature Research and Communication	22.5	1h30				1	1	50%	50%
Discovery Teaching Unit									
DTU1 (O/P) Sea-Related Activities									
Course 1 : Workshop 2 Sea-Related Activities	22.5				22.5	1	1	50%	50%
Total Semestre 2	375h								

2. Semester 3

Teaching Unit	SHV	Weekly Hourly Volume				Coeff	Credit	Assessment Method	
	14-16 Week	L	GS	PW	Other			Continuous Assessment	Exam
Fundamental Teaching Unit									
FTU 1 : Enzyme Engineering & Marine Algae Biotechnology									
Course 1 : Enzyme Engineering	67.5	1h30	1h30	1h30		3	6	50%	50%
Course 2 : Marine Algae Biotechnology	67.5	3 h	45 min	45min		3	6	50%	50%
FTU .2 : Cell Culture & Genetic Improvement									
Course 1 : Cell Culture & Genetic Improvement	67.5	3h	45 min	45 min		3	6	50%	50%
Methodology Teaching Unit									
MTU 1 (O/P) : Bioinformatics & Process Engineering									
Course 1 : Bioinformatics & Omics	67.5	3h	1h30			3	5	50%	50%
Course 2 : Unit Operations/Macroscopic Balances	45	1h30	1h30			2	3	50%	50%
Course 3 : Experimental Design Methodology	45	1h30	1h30			2	3	50%	50%
Discovery Teaching Unit									
DTU 1 (O/P) : Sustainable Development									
Course 1 : Sustainable Development	15	1h				1	1	50%	50%
Total Semester 3	375h								

3. Semester 4

Teaching Unit	SHV	Weekly Hourly Volume				Coeff	Credit	Assessment Method	
	14-16 Week	L	GS	PW	Other			Continuous Assessment	Exam
Fundamental Teaching Unit									
FTU 1 : Microbial Biotechnology & Biopolymer Chemistry									
Course 1 : Microbial Biotechnology	67.5 h	3 h	45mn	45mn		3	6	50%	50%
Course 2 : Polymer Chemistry (Biopolymers)	45 h	1h30	45mn	45mn		2	4	50%	50%
FTU.2 : : Immunotechnology & Valorization of Animal-derived Biomolecules									
Course 1 : Immunology & Immunotechnology	45 h	1h30	45mn	45mn		2	4	50%	50%
Course 2 : Valorization of Animal-derived Biomolecules	45 h	1h30	45mn	45mn		2	4	50%	50%
Methodology Teaching Unit									
MTU (O/P) : Biomarkers in Marine Ecotoxicology									
Course 1 : Biomarkers/Biomonitoring	45 h	1h30	45mn	45mn		2	3	50%	50%
MTU 2(O/P) : Entrepreneurship, Business Management & Professional Integration									
Course 1 : Internship & Professional Integration	60 h				60 h	3	5	50%	50%
Course 2 : Entrepreneurship & Business Management	45 h	1h30	1h30			2	3	50%	50%
Transversal Teaching Unit									
TTU 1 (O/P) :									
Course 1 : English	22.5 h	1h30				1	1	50%	50%
Total Semester 4	375h								

4. Semester 5

Teaching Unit	SHV	Weekly Hourly Volume				Coeff	Credit	Assessment Method	
	14-16 Week	L	GS	PW	Other			Continuous Assessment	Exam
Fundamental Teaching Unit									
FTU 1 : Biocorrosion, Anti-fouling & Biotechnological Remediation Processes									
Course 1 Marine Bioremediation & Bioprocesses	67.5 h	1h30	1h30	1h30		3	6	50%	50%
Course 2 : Biocorrosion & Anti-fouling	45 h	1h30	1h30			2	4	50%	50%
FTU 2 : Economics & Project Management									
Course 1 : Marine Environmental Economics	45 h	1h30	1h30			2	4	50%	50%
Course 2 : Project Management	45 h	1h30	1h30			2	4	50%	50%
Methodology Teaching Unit									
MTU 1 (O/P) : Quality Control Techniques									
Course 1 : Microbial Control Techniques	45 h	1h30		1h30		2	4	50%	50%
Course 2 : Toxicological-Pharmacological Controls	45 h	1h30	45mn	45m		2	4	50%	50%
MTU 2 (O/P) : Bioethics, Innovation & Intellectual Property									
Course 1 : Bioethics/Biosafety	22.5 h	1h30				1	1	50%	50%
Course 2 : Innovation & Intellectual Property	22.5 h	1h30				1	1	50%	50%
Transversal Teaching Unit									
TTU 1 (O/P) : English & Maritime Law									
Course 1 : Maritime & Environmental Law	22.5 h	1h30				1	1	50%	50%
Course 2 : English	15 h	1h				1	1	50%	50%
Total Semester 5	375h h								

5. Semester 6

Field: Natural and Life Sciences (NLS)

Program: Marine and Continental Hydrobiology (MCH)

Specialization: Marine Biotechnology

Internship program culminating in a thesis and defense.

	SHV	Coeff	Credits
Individual Work	500h	11	20
Corporate Internship	250h	6	10
Seminars	-	-	-
Other (specify)	-	-	-
Total Semester	750h	17	30

6. Overall Summary of the Training Program

TU / HV	FTU	MTU	TTU	DTU	PFE	Total
Lectures (L)	517.5	337,5	97,5	15	0	967.5
Guided Study (GS)	258.75	213,75	0	0	0	472.5
Practical Work (PW)	236 ,25	78,75	0	0	0	315
Individual Work	1012,5	630	97,5	15	500	2255
Other (specify)	0	97,5	0	22,5	250	370
Total	2025	1357,5	195	52,5	750	4380
Credits	90	53	5	2	30	180
% of Total Credits for each TU	**50%**	**29,44%**	**2,78%**	**1,11%**	**16,67%**	**100%**

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

III. Detailed Program by Course

Institution: ENSSMAL
Academic Year: 2023-2024

Program Title: Marine Biotechnology

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

Semester : 1

Institution: ENSSMAL
Academic Year: 2023-2024

Program Title: Marine Biotechnology

Degree Title: Marine Biotechnology

Semester: 1

FTU Title: Fundamental Teaching Unit 1 Ecologie marine et Pollution

Course 01: Marine Ecology

Hours: 67.5	**Credits: 06**	**Coefficients: 03**

Teaching Objectives:
Introduction to practical marine ecology and development of knowledge on marine ecology, particularly the functioning of pelagic and benthic ecosystems.

Prerequisites: General biology and general ecology

Course Content (22.5 H):

Chapter I: Foundations of Marine Ecology and Basic Concepts

1. Subdivisions and Zonation
   - 1.1. Pelagic Zone
   - 1.2. Benthic Zone
2. Ecological Factors
   - 2.1. Abiotic Factors
   - 2.1.1. Hydrological Factors
   - 2.1.2. Edaphic Factors
   - 2.2. Biotic Factors
   - 2.3. Human Factors
   - 2.4. Other Factors

Chapter II: Pelagic Zone

1. General Knowledge
2. Adaptations to Pelagic Life
   - 2.1. Size and Coloration
   - 2.2. Suspension, Buoyancy, Mobility, and Morphological Adaptations
3. Plankton Composition
   - 3.1. Phytoplankton
   - 3.2. Zooplankton
4. Nekton
   - 4.1. Definition
   - 4.2. Composition
   - 4.3. Mobility and Morphological Adaptations
   - 4.4. Gregarious Behavior
   - 4.5. Migration
5. Sampling Methods

Chapter III: Benthic Zone

1. Definition
2. Adaptations to Benthic Life
3. Substrate as a Structuring Factor
   - 3.1. Substrate Varieties
   - 3.2. Hard-Bottom Communities
   - 3.3. Soft-Bottom Communities
4. Feeding Requirements and Modes
5. Reproduction Aspects and Strategies

6. Sampling Methods

Chapter IV: Production

1. Primary Production
2. Secondary Production and Trophic Cycles in Marine Environments

Chapter V: Remarkable Communities, Protected and Invasive Species in the Mediterranean

1. Remarkable Mediterranean Communities and Habitats
2. Protected Species and Regulations
3. Invasive Species

Tutorials (22.5 H):

1. Analysis of Nekton Community Data (6 H)
2. Benthic Bionomy: Analytical Characteristics of Communities (3 H)
3. Benthic Bionomy: General Characteristics (3 H)
4. Benthic Bionomy: Ecological Groups and Benthic Indices (3 H)
5. Numerical Study and Analysis of Posidonia (6 H)

Practical Work (22.5 H):

1. Field Trip: Ecological Discovery of the Marine Environment and Plankton Sampling (6 H)
2. Lab Work: Preliminary Identification of Collected Plankton Samples (3 H)
3. Field Trip: Sampling Methods for Mid- and Upper Intertidal Fauna and Flora (6 H)
4. Lab Work: Preliminary Identification of Collected Benthic Samples (3 H)
5. Field Trip: Visit to a Remarkable Site—Vermetid Tidal Flats and Posidonia Barrier Reefs (3 H)

Assessment Method: Determined by the teaching team.

References:

- Albin, Michel (1999). *Dictionary of Ecology*.
- Bayer, E. et al. (2009). *Guide to Mediterranean Flora*.
- Bellan-Santini, D. et al. (1994). *Marine and Coastal Biocenoses of the Mediterranean*.
- Collignon, Jean (1991). *Marine Ecology and Biology: Introduction to Fisheries Science*.
- Ramade, François (2002). *Encyclopedic Dictionary of Ecology and Environmental Sciences*.
- Zenetos, Argyro et al. (2003). *CIESM Atlas of Exotic Species in the Mediterranean*.

Degree Title: Marine Biotechnology

Semester: 1

FTU Title: Fundamental Teaching Unit 1
Ecologie marine et Pollution

Course 02: Marine Pollution

Hours: 45	**Credits: 04**	**Coefficients: 02**

Teaching Objectives:
Provide students with comprehensive knowledge of marine pollution issues, particularly in coastal and marine environments, to understand the environmental applications of marine biotechnology.

Prerequisites: General biology, general chemistry (organic and inorganic), general microbiology, general ecology, and marine ecology.

Course Content (22.5 H):

I. Introduction to Environmental Pollution
1. Pollution of Seas and Oceans
2. Pollution at Land-Sea Interfaces
3. Air Pollution and Atmospheric Deposition

II. Pollution Typology
1. Types of Pollution
   1.1. Chemical Pollution
   1.1.1. Hydrocarbons
   1.1.2. Organic and Nitrogen Compounds
   1.1.3. Persistent Organic Pollutants (POPs)
   1.1.4. Metals
   1.2. Biological Pollution
   1.2.1. Bio-Invasion
   1.2.2. Microbiological Pollution
   1.3. Physical Pollution
   1.3.1. Thermal Pollution
   1.3.2. Radiation Pollution
   1.3.3. Suspended Solids/Plastic Pollution
   1.3.4. Noise Pollution (Nautical Traffic)
2. Pollution Scales
   2.1. Diffuse Pollution
   2.2. Point Source Pollution
   2.3. Accidental Pollution
3. Pollution Sources
   3.1. Industrial Pollution
   3.2. Urban Pollution
   3.3. Agricultural Pollution
   3.4. Natural Pollution

Practical Work (22.5 H):

Field Trip and Sampling:
- In-situ measurements (color, temperature, pH, dissolved oxygen, conductivity, salinity, turbidity).

Lab Measurements:

- Physicochemical parameters (MES/MO/MM content, orthophosphates, nitrates, nitrites, ammonium).
- Microbiological parameters (coliforms, streptococci, pathogenic germs—Vibrios, Salmonella).

<table>
<tr><td colspan="3">Degree Title: Marine Biotechnology</td></tr>
<tr><td colspan="3">Semester: 1</td></tr>
<tr><td colspan="3">FTU Title: Fundamental Teaching Unit 2
Molecular Biology and Diversity of Marine Microorganisms</td></tr>
<tr><td colspan="3">Course 01: Molecular Biology</td></tr>
<tr><td>Hours: 45</td><td>Credits: 04</td><td>Coefficients: 02</td></tr>
<tr><td colspan="3">Teaching Objectives:
Covers theoretical foundations of molecular biology in eukaryotes and prokaryotes (functioning and regulation).</td></tr>
<tr><td colspan="3">Prerequisites: General biology, general genetics.</td></tr>
<tr><td colspan="3">Course Content (22.5 H):
I. Nucleic Acids: Structure, Organization, and Replication
1. Structure of Nucleic Acids
2. Prokaryotic Genome (Chromosomal DNA, Plasmids, Transposons)
3. Eukaryotic Genome (Chromosomal DNA, Organelle Genomes—Mitochondria, Chloroplasts)
4. Replication (Prokaryotes and Eukaryotes)
II. Gene Expression and Regulatory Signals
1. Transcription in Prokaryotes
2. Transcription in Eukaryotes
3. Transcriptional Regulation
3.1. Prokaryotes (Inducible Operons, Repressible Operons, Regulons, Riboregulators)
3.2. Eukaryotes (Chromatin Regulation, Transcriptional Regulation, Post-Transcriptional Regulation)
4. Translation (Prokaryotes and Eukaryotes)
4.1. Translation Machinery
4.2. Protein Synthesis Steps
4.3. Translation Regulation
4.4. Post-Translational Regulation
Tutorials: Exercises and article analyses.</td></tr>
</table>

Degree Title: Marine Biotechnology		
Semester: 1		
FTU Title: Fundamental Teaching Unit 2 **Molecular Biology and Diversity of Marine Microorganisms**		
Course 02 : Diversité et Systématique des microorganismes marins		
Hours: 45	**Credits: 04**	**Coefficients: 02**
Teaching Objectives: Study microbial diversity, strain purification, and classification/identification methods.		
Prerequisites: General microbiology, general genetics, molecular biology.		

Course Content:

1. **Microbial Systematics**
   - **1.1. Taxonomy, Taxa, Nomenclature, and Methods**
   - **1.2. Species Concept and Classification**
   - **1.3. Microbial Diversity in Marine Environments**
2. **Marine Bacteria**
   - **2.1. Bacterial Diversity**
   - **2.2. Major Bacterial Groups and Classification**
3. **Marine Fungi**
   - **3.1. Definition and Classification**
   - **3.2. Major Fungal Groups (Molds, Yeasts)**
4. **Marine Archaea**
   - **4.1. Cellular Structure and Function**
   - **4.2. Classification (Euryarchaeota, Crenarchaeota)**
5. **Marine Viruses**
   - **5.1. Structure and Genetic Composition**
   - **5.2. Virus Classification**
   - **5.3. Role of Viruses in Seawater**

Practical Work (TP)

TP1: Observation of microbial diversity in fresh samples (plant macerates, aquarium water, Petri dish colonies, etc.)

TP2: Surface and depth enumeration of total aerobic mesophilic flora

TP3: Observation and identification of micromycetes (molds and yeasts) from moldy food samples and Petri dishes

TP4: Detection of pathogenic organisms in seawater and marine species using filtration methods

Tutorials (TD)

TD1: Safety protocols and regulations in microbiology laboratories

TD2: Culture media and cultivation techniques

Other

Student assessment:

- **Poster-form reports**
- **Continuous PW/GS assessments**

- **Presentation on marine viruses**

6. **Assessment method:**
   Continuous assessment: 50%
   Midterm exam: 50%
7. **Note: All technical terms (TP/TD, EMD) and scientific terminology have been preserved in their standard English equivalents while maintaining the original structure.**

Engineering title: marine biotechnology		
Semester : 1		
Title of the MTU: Methodology Teaching Unit I Analysis techniques		
Course 01: Instrumental Analysis Techniques		
Hourly volume : 67.5 H	**Credits: 05**	**Coefficients: 03**
Teaching objectives: These courses are taught in specialized laboratories reserved for biotechnology and biochemistry Students are required as part of the "technological activities in biochemical analysis" to: - prepare, calibrate and package titrant solutions, buffer solutions, reagents and media necessary for analyses and controls; - prepare the equipment and facilities necessary for the implementation of the techniques Addressed; - carry out the measurements of physico-chemical parameters necessary for the conduct of the analyses carried out; - analyse and prevent the individual, collective and environmental risks associated with these technological activities; - Comply with regulatory and normative constraints.		
Prerequisites: General Biochemistry		

Content of the subject: course (27H)

1. Sample and Product Preparation and Storage

1.1. Grinding, homogenization
1.2. Mineralization, calcination
1.3. Evaporation, dessiccation
1.4. Centrifugation, ultracentrifugation
1.5. Filtration, ultrafiltration
1.6. Precipitation, release
1.7. Dialysis, reverse osmosis
1.8. Sonication
1.9. Distillation

2. Gravimetric and physicochemical analyses

2.1. Determination of dry matter content
2.2. Determination of ash content, determination of percentages of organic and mineral matter
2.3. Determination of aw *(water activity)
2.4. Determination of the rheological characteristics of a sample

3. Volumetric and electrochemical analyses

3.1. Determination of equivalence points
3.1.1. Chemical methods - Acidimetry - Oxidation-reduction
3.1.2. Physical methods
- pHmetry - Potentiometry
- Conductimetry

4. Analyses using optical methods

4.1. Polarimetry
Refractometry 4.3. Molecular absorption spectrophotometry 4.3.1. UV-Visible
4.3.2. IR* 4.3.3. IRTF*
4.4. Atomic absorption spectrophotometry
4.5. Molecular emission spectrophotometry
4.5.1. Fluorimetry 4.5.2. Bioluminescence*
4.5.3. Chemiluminescence* 4.6. Atomic emission spectrophotometry
4.6.1. Flame photometry 4.6.2. Plasma emission spectrophotometry* .
4.7. Photometry of turbid media
4.7.1. Turbidimetry
4.7.2. Nephelometry

5. Analyses using chromatographic techniques

5.1. Thin-layer chromatography (TLC).
5.2. Low-pressure liquid chromatography (Mention will be made of the preparative use of this technique).
5.2.1. Sharing

5.2.2. Adsorption
5.2.3. Technical affinity to be studied in relation to the program of technological activities in cellular and molecular biology.
5.2.4. Gel filtration 5.2.5. Ion exchange
5.2.6. Hydrophobicity
5.3. Isocratic high-performance liquid chromatography (HPLC), gradient and associated detectors (The preparative use of this technique will be mentioned. The principles of the various detectors that can be used, including the mass spectrometry detector, will be presented.
5.4. Gas chromatography (GC), associated detectors

6. Analyses using electrophoretic techniques

6.1. Native protein electrophoresis
6.2. SDS-PAGE Electrophoresis
6.3. Agarose gel electrophoresis.
6.4. Capillary Electrophoresis*
6.5. Electrofocusing*
6.6. Two-dimensional electrophoresis*
6.7. Immunoelectrophoresis, Western Blot

7. Analyses using enzymatic techniques

7.1. Determination of enzymatic activities
7.2. Substrate Assay by Enzymatic Method
7.2.1. Endpoint Methods
7.2.2. Kinetic methods
7.3. Production and use of specific electrodes (enzymatic sensors)

Tutorials and practical work

Tutorial N° 1: Introduction to Metrology: Units and Equations with Dimensions
Tutorial N° 2: Error calculation
Tutorial N° 3 UV-Visible Spectrophotometry
Lab N°1 Liquid-liquid extraction
Lab N°2 Liquid-solid extraction
Lab N°3: Determination of methylene blue by UV-Visible spectroscopy
Lab N°4: Column chromatography
TP N°5 Electrophorèse SDS-PAGE

Assessment method: Continuous assessment: 50% + **Exam: 50%**

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 1</td></tr>
<tr><td colspan="3">Title of the MTU: Methodology Teaching Unit 01 Analysis techniques</td></tr>
<tr><td colspan="3">Course 02: Biostatistics</td></tr>
<tr><td>Hourly volume: 45 hours</td><td>Credits: 03</td><td>Coefficients: 02</td></tr>
<tr><td colspan="3">Teaching objectives: To know the specific vocabulary of statistics; Understand the principles of data processing; • The choice of the appropriate statistical method for each particular situation; • Performing basic calculations and tests for one and two variables.</td></tr>
<tr><td colspan="3">Prerequisites: Descriptive Statistics</td></tr>
<tr><td colspan="3">Contenu de la matière : cours (22.5 H)
(2h) Rappel Statistique Descriptive uni et bi dimensionnelle (polycopié résumé du cours effectué en S1 tronc commun)
(2h) Rappel variables aléatoires et modèles probabilistes théoriques (polycopié résumé du cours effectué en S4 tronc commun
(4h) Chapitre 1 : Echantillonnage
1. Méthodes d’échantillonnage (aléatoire et simple, stratifié, par grappes, aléatoire systématique et par quotas)
2. Distributions d’échantillonnage
a. Distribution d’échantillonnage de la moyenne
b. Distribution d’échantillonnage de la variance
c. Distribution d’échantillonnage de la proportion

(2h) Chapitre 2 : Estimation (ponctuelle et par intervalle de confiance)

(2h) Chapitre 3 : Tests de normalité
1. Table de nombres aléatoires
2. Test graphique –Droite de Henry-
3. Test de Kolmogorov-Smirnov
(5h) Chapitre 4 : Tests paramétriques
1. Test de comparaison de deux moyennes
2. Test de comparaison de deux proportions
3. Test de comparaison de deux variances
4. Test de conformité d’une pente
5. Test de comparaison de plusieurs moyennes (Analyse de la variance)
(4h) Chapitre 6 : Tests non paramétriques
1. Test de Mann et Whitney (comparaison de deux moyennes de deux petits échantillons indépendants)
2. Test de Wilcoxon (comparaison de deux moyennes de deux petits échantillons appariés)
3. Test de Kruskall & Wallis
4. Test du Khi-deux</td></tr>
</table>

TD/TP Program: 21 hours

Descriptive Statistical Reminder / Random Variables and Theoretical Probabilistic Models (4.5 h)

Session 1	TP 1
Session 2	TP 2
Session 3	TP 3

Chapter 1: Sampling Methods and Distributions (3 h)

Session 1	Exercise Series
Session 2	TP 1

Chapter 3: Estimation (3 h)

Session 1	Exercise Series
Session 2	TP 1

Chapter 4: Normality Tests (3 h)

Session 1	TP 1
Session 2	TP 2

Chapter 5: Parametric Testing (3 h)

Session 1	TP 1
Session 2	TP 2

Chapter 6: Nonparametric Tests (4.5 h)

Session 1	Exercise Series
Session 2	TP 1
Session 3	TP 2

References:

Dagnelie P. 2013. Theoretical and applied statistics. Volume 1. Descriptive statistics and the basis of statistical inference. *Brussels, De Boeck*, 517 p.

- **Tukey J. W.1953.** "The Problem of Multiple Comparisons," Mimeographed Monograph, *Princeton University.*
- **Scheffé, H. 1953.** A method for judging all contrasts in the analysis of variance, *Biometrika*, 40: 87 – 104.
- **Wayne, W. D. et Chad L.C., C. L. 2018**. Biostatistics: a foundation for analysis in the health sciences. *Wiley*.

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 1</td></tr>
<tr><td colspan="3">Title of the MTU: Methodology Teaching Unit 2 Heat and Matter Transfer</td></tr>
<tr><td colspan="3">Course 01 : Heat Transfer and Matter Transfer</td></tr>
<tr><td>Hourly volume: 45 hours</td><td>Credits: 03</td><td>Coefficients: 02</td></tr>
<tr><td colspan="3">Teaching objectives: this subject is subdivided into two parts At the end of this course, students should be able to: Know the main modes of heat transfer. Measure heat flows in different systems. Apply the principles of conservation and the appropriate constituting laws.</td></tr>
<tr><td colspan="3">Prerequisites: To follow this course effectively, it is preferable to have a basic knowledge of thermodynamics as well as a basic knowledge of mathematics.</td></tr>
<tr><td colspan="3">Content of the subject: course (22.5 H)
CHAPTER I: Material Transfer Mechanism
1. Introduction
2. Diffusive transfer
-Fick's Law
-Definition of molecular diffusion
-Notions of material flux density
-Definition of molar and mass mean velocities
3. Convective transfer
4. Combined transfer: diffusion + convection
5. Conclusion
CHAPTER II: Description of the transfer of matter
1. Introduction
2. Material Balance-Continuity Equation
3. Reminders on gradient operators and divergence of a vector
4. Total Mass Balance on a Fixed Volume Element
5. Balance of the mass of a constituent i on a fixed volume element
6. Boundary and initial conditions
7. Steady-state diffusive transfer
Diffusion of a gas through a stagnant gas film
Equimolar diffusion

TD Series:
Series 1: Calculations of concentrations, material flux densities and velocities

Series 2: Diffusion and convection material transfer</td></tr>
</table>

PART 2. HEAT TRANSFER

I. Introduction
II. Thermal transmission modes
III. Temperature field
IV. Thermal conduction: Fourier's law
V. Conservation of energy: Equation of energy or heat **VI.** Stationary Heat Flow

VI.1. Heat transfer by conduction.

-Flat wall
-Multilayer composite wall
-Hollow cylindrical pipe
-Multi-layer jacketed pipe

VI.2. Convection heat transfer

• Partial and global convection transfer conductances
-Cylindrical pipe covered with an insulating sleeve
-Determination of the convection thermal coefficient

VI.3. Radiant heat transfer

-Characteristic of thermal radiation
-Emission, absorption, reflection-diffusion, transparency and opacity
-Relationships between luminous fluxes, notion of equilibrium radiation
-Definition of *the "black body",* Planck's, Wien's and Stephan's laws
-Radiation from real surfaces

TD Series:

Series 1: Conductive Heat Transfer
Series 2: Convection Heat Transfer
Series 3: Radiant Heat Transfer

Assessment method: Continuous assessment: 50% + **EMD: 50%**

Engineering title: marine biotechnology		
Semester : 1		
Title of the Intitulé Transversal Teaching Unit		
Course 01 : English for Specific Purpose (ESP)		
Hourly volume: 15 H	**Credits: 01**	**Coefficients: 01**
Teaching objectives:		
This program is intended for future engineers to allow them to acquire basic knowledge of the English language, in order to be able to analyze a corpus containing key words, or scientific terminology. A scientific document is a text that contains scientific terms, written in a clear and concise style. The student must master linguistic tools to be able to understand the objective of a scientific text. The program consists of four (04) units, each of which contains a set of basic grammar knowledge, vocabulary related to a scientific theme, which will be developed by personal research by the student as preparation for an oral presentation. Each unit is followed by a series of exercises and a lexicon relating to the theme.		

Content of the subject: course (21H) Unit 1: Measurements

- Describing the dimensions of an object :
- Height, Width, Weight, depth, rate …… - Exercises : How much …. ? How far…. ?
- Video : How to talk about measurements ?
- Lexicon

Unit 2 : Frequency

-To say how often something does happen ?

- Usually, often, rarely, sometimes, once , twice….. - Review of Present Simple tense.
- Exercises and activities through text study. - Lexicon

Unit 3 : Comparison

- Comparative adjectives : …… is bigger than……
- Superlative Adjectives : The biggest, the best, ……
- Similarity : …..as big as ……..
- Exercises and activities through text study.
- Lexicon

Unit 4 : Modification

- Premodification: Determiners, adjectives
- Postmodification : Relative clauses introduced by Who, which, that……. - Exercises and activities through text study. - Lexicon

Method of evaluation:

Continuous assessment: 50% + **EMD: 50%**

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

Semester : 2

Institution: ENSSMAL
Academic Year: 2023-2024

Program Title: Marine Biotechnology

Engineering title: marine biotechnology		
Semester : 2		
Title of the course: Fundamental UEF1 Systematics of marine organisms		
Title of subject 01: Systematics of marine plants		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**

Teaching objectives:
To know the classification of marine plants and to acquire dissection and cutting techniques for the study of plant cells and tissues

Recommended prior knowledge: plant biology, botany,

Content of the subject: course (22.5 H)

1. Introduction
2. Taxonomic nomenclature code
3. General presentation of the marine plant world

3.1. ALGAE
3.1.1. Classification system
3.1.2. Main groups and their characteristics
3.1.2.1. Division CYANOBACTERIA (Cyanophyta)
- Taxonomy subunits (Classes, Orders, Genera and Species)

3.1.2.2. RHODOPHYTA (Rhodobionta)
A/ BANGIOPHYCEAE
- Taxonomy subunits (Classes, Orders, Genera and Species)
B/ FLORIDEOPHYCEAE
- Taxonomy subunits (Classes, Orders, Genera and Species)

3.1.2.3. OCHROPHYTA
A/ Phaeophyceae
- Taxonomy subunits (Classes, Orders, Genera and Species)
B/ Bacillariophyceae
C/ Dinophyceae

3.1.2.4. CHLOROPHYTA (Chlorobionta)
- Taxonomic subunits (Class, Orders, Genera and Species)

3.2. SPERMATOPHYTAE (Magnoliophytes, Phanerogams)
3.2.1 Systematic position (in relation to terrestrial spermaphytes) 3.2.2. Peculiarities
3.2.3. Characterization of the different genera and species

Practical work and tutorials (9 p.m.)
1/-Methods of studying marine plants and methods of conservation
2/ CYANOPHYTA: morphology, cytology, specific identification - systematic position and biotechnological interest

3/ RHODOPHYTA: morphology, cytology, specific identification - systematic position and biotechnological interest.
4/ OCHROPHYTA: morphology, cytology, specific identification - systematic position and biotechnological interest.
5/ CHLOROPHYTA: morphology, cytology, specific identification - systematic position and biotechnological interest.
6/ SPERMATOPHYTAE (Phanerogams, Magnoliophytes): differentiation of the different genera and specific identification
7/ Field trip

Engineering title: marine biotechnology		
Semester : 2		
Title of the course: Fundamental UEF 1 Systematics of marine organisms		
Title of subject 02: Systematics of marine invertebrates		
Hourly volume: 37.5 H	**Credits: 04**	**Coefficients: 02**
Teaching objectives: Acquisition of the knowledge necessary for the recognition and identification of marine species belonging to the vertebrate subphylum.		
Recommended prior knowledge: animal biology, zoology		

Content of the subject: course (22.5 H)

- **Courses (22.5 H)**

Chapter I: Definitions and basic concepts

1. **Systematic**
2. **Taxonomy**
3. **Phylogeny**
4. **Phenetics**
5. **Cladistic**
6. **Morphology**
7. **Anatomy**
8. **Physiology**
9. **Ethology**
10. **Essential rules of zoological nomenclature according to the ICZN**

Chapter II: Current Classification of Vertebrates

1. **Reference Documentation**
2. **Current summary systematics**

Chapter III: Agnatha

1. **Myxini**
2. **Petromyzonti**

Chapter IV: Chondrichthyes

1. **Elasmobranchii**
2. **Holocephali**

Chapter V: Osteichthyes

1. **Actinopterygii**
2. **Sarcopterygii**

Chapter VI: Tetrapoda

1. **Mammalia**
2. **Testudines**
3. **Aves**

- **Activities and Practical Work (7.5 H)**

1. Lab 01: Agnathans and Chondrichthyes
2. Lab 02: Osteichthyes

Evaluation method: left to the discretion of the training team.

References

- Baer, Jean G., 1965. *Course in Comparative Anatomy of Vertebrates.* Paris: Griffon. 206 p.
- Devillers, Charles and P. Clairambault, 1976. *Vertebrate zoology handbook:*

  Comparative Anatomy (Volume 1). Paris: Dunod. 468 p.
- Grassé, Pierre-P. and Charles Devillers, 1965. *Zoology: vertebrates (volume 2).* Paris: Dunod. 1129 p.
- Grassé, Pierre-Paul et al., 2000. *Vertebrate Zoology.* Paris: Masson. 198 p.
- Picaud, Jean-Louis et al., 2004. *Animal biology: vertebrates.* Paris: Masson. 298 p.

https://www.iczn.org/the-code/the-international-code-of-zoological-nomenclature/.

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 2</td></tr>
<tr><td colspan="3">Title of the course: Fundamental UEF 1 Systematics of marine organisms</td></tr>
<tr><td colspan="3">Title of subject 03: Systematics of marine vertebrates</td></tr>
<tr><td>Hourly volume: 30 hours</td><td>Credits: 02</td><td>Coefficients: 01</td></tr>
<tr><td colspan="3">Teaching objectives: Acquisition of the knowledge necessary for the recognition and identification of marine species belonging to the vertebrate subphylum</td></tr>
<tr><td colspan="3">Recommended prior knowledge: animal biology, zoology, embryology.</td></tr>
<tr><td colspan="3">Material content
➢ Courses (22.5 H)

Chapter I: Definitions and basic concepts
5. Systematic
6. Taxonomy
7. Phylogeny
8. Phenetics
9. Cladistic
10. Morphology
11. Anatomy
12. Physiology
13. Ethology
14. Essential rules of zoological nomenclature according to the ICZN

Chapter II: Current Classification of Vertebrates
7. Reference Documentation
8. Current summary systematics

Chapter III: Agnatha
11. Myxini
12. Petromyzonti

Chapter IV: Chondrichthyes
5. Elasmobranchii
6. Holocephali

Chapter V: Osteichthyes
3. Actinopterygii
4. Sarcopterygii

Chapter VI: Tetrapoda
3. Mammalia
4. Testudines</td></tr>
</table>

- **Activities and Practical Work (7.5 H)**

1. Lab n°01: Agnathans and Chondrichthyes
2. TP n°02 : Osteichthyes

Evaluation method: left to the discretion of the training team.

References

- Baer, Jean G., 1965. *Course in Comparative Anatomy of Vertebrates.* Paris: Griffon. 206 p.
- Devillers, Charles and P. Clairambault, 1976. *Vertebrate zoology handbook: Comparative Anatomy (Volume 1).* Paris: Dunod. 468 p.
- Grassé, Pierre-P. and Charles Devillers, 1965. *Zoology: vertebrates (volume 2).* Paris: Dunod. 1129 p.
- Grassé, Pierre-Paul et al., 2000. *Vertebrate Zoology.* Paris: Masson. 198 p.
- Picaud, Jean-Louis et al., 2004. *Animal biology: vertebrates.* Paris: Masson. 298 p.

https://www.iczn.org/the-code/the-international-code-of-zoological-nomenclature/.

Engineering title: marine biotechnology		
Semester : 2		
Title of the course: Fundamental UEF 2 Marine Ecophysiology and Cell Signaling		
Subject Title 01: Physiology and Ecophysiology of Marine Organisms		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**

Teaching objectives:
To understand the diversity of adaptive responses in the marine environment for the most important zoological groups (crustaceans, echinoderms, molluscs, fish, marine vertebrates) and plants, and to understand the different mechanisms and physiological processes adaptive from the cell to the organism.

Recommended prior knowledge: general biology, zoology, marine ecology.

Content of the subject: course (22.5 H)
Material content

1. Introduction/ Physiology of the major functions of vertebrates and invertebrates (Circulation, Respiration,,Excretion, osmo-regulation, Digestion, nutrition and Metabolism, Reproduction, Development and Growth)

1.1. Definition of Ecophysiology
1.2. Central Themes of Physiology
1.3. Reminders of the environmental constraints specific to the marine environment

2. Gas exchange and circulation

2.1. Introduction
2.2. Gas exchange at the respiratory surfaces
2.3. Ventilatory systems that improve gas exchange
2.4. Circulatory systems
2.5. Transfer of gases in tissues
2.6. Adaptation to hypoxia and anoxia

3. Osmoregulation and excretion

3.1. . General – Terminology
3.2. Osmoregulation mechanisms in marine invertebrates and vertebrates and organs involved
3.3. Osmoregulatory adaptations to salinity variations
3.4. Nitrogenous waste excretion and living environment

4. Thermoregulation

4.1. General Introductions – Terminology
4.2. Ectothermy: Tolerance
4.3. Ectothermy: Thermoregulation
4.4. Endotherm: Thermoregulation

5. Adaptations to hydrostatic pressure

5.1. Introductory general
5.2. Effects of depth and pressure

5.4 Adaptations to High Hydrostatic Pressures
6. Hormones: endocrine modulators
6.1. Different types of hormones and how they work
6.2. Endocrine control of the hydromineral balance in bony fish

Tutorials

1. Comparison of osmoregulation in freshwater and seawater elasmobranchs (Study of a review article)
2. Ecophysiology of aquatic organisms in extreme environments (Abyssal Zone, Polar Zones and Hydrothermal Vents)
3. Impact of climate change (acidification, temperature increase, etc.) on marine organisms (2 sessions)
4. Anatomical and physiological adaptations of intertidal zone organisms (Creation of a poster)
5. Behavioral and physiological adaptations to buoyancy
6. Presentation based on review articles or recent research published in physiology journals (3 sessions)

Practical work

Respiratory and metabolic responses of oxygen content and salinity in a bony fish and/or mollusk (mussel)
Field trip
Intertidal Exit

Method of evaluation:

Continuous assessment: 50%
Exam : 50%

Engineering title: marine biotechnology

Semester : 2

Title of the course: Fundamental UEF 2 Marine Ecophysiology and Cell Signaling

Subject Heading 02: Communication and Cell Signaling

Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**

Teaching objectives: This module illustrates signaling and intra- and inter-cellular communication. The student will have the necessary and up-to-date knowledge of signaling stunts. Indeed, cell signaling has become an integral part of modern biology given its role in controlling the internal functioning of organisms, allowing them to respond, adapt and survive in a given environment.

Recommended Prerequisites: General Biology, Biochemistry

Content of the subject: course (22.5 H)

1- General aspects of cell signaling

- Receptor-ligand interaction
- Molecular Switches

2- G-protein-coupled receptor pathways

- G proteins
- Effector pathways involved by G proteins Role of calcium in signal transduction

3- Ion channel-coupled receptor signaling

- General Organization of Ion Channel-Coupled Receptors
- Calcium Mobilization Signals

4- Receptors with tyrosine kinase activities

- ERBB receptors
- The MAP Kinase pathway

5- Cell signaling and differentiation

- The Wnt Way
- La voie Notch

Tutorials (Each tutorial will be done in two sessions)

1- Cell Signaling Fundamentals
2- Role of Second Messengers in Cell Signaling
3- Alterations in the G protein pathway
4- Alteration of the MAPK pathway
5- Role of the Notch pathway in cell differentiation

Engineering title: marine biotechnology

Semester : 2

Title of the course: UEM Methodology 1 Multidimensional Analysis and Digital Imaging

Subject Title 01: Multidimensional Data Analysis (MDA)

Hourly volume: 45 hours	**Credits: 03**	**Coefficients: 02**

Teaching Objectives: This course aims to understand, implement and interpret the results of the fundamental, multidimensional exploratory analysis methods of ACP, AFC, ACM classification and AFM data**.**

Recommended prior knowledge: descriptive statistics, biostatistics

Course program: 22.5 hours

Chapter 1: Multiple Correlations and Regressions

1. The double regression model
2. Step by step regression

Chapter 2: Reminders on matrix matrices and matrix functions

Chapter 3: Factor analyses

1. Principal Component Analysis (PCA)
2. Correspondence Factor Analysis (CFA)
3. Discriminant Factor Analysis (DFA)
4. Multiple Correspondence Analysis (MCA)

Chapter 4: Classification Methods

1. Hierarchical Ascending Classification (CAH) Method
2. K-Averages
3. Joint classification

TD Program: 22.5 hours

Tutorial 1- Correlations and double multiple regression (1 session)
Tutorial 2- Step by step regression (2 sessions)
Tutorial 3- Principal Component Analysis (PCA) (2 sessions)
Tutorial 4- Correspondence Factor Analysis (CFA) (2 sessions)
Tutorial 5- Discriminant Factor Analysis (AFD) (1 session)
Tutorial 6 - Multiple Correspondence Analysis (MCA) (1 session)
Tutorial 7- Hierarchical Ascending Classification (CAH) Method (2 sessions)
TD 8- K-Averages (1 session)
Tutorial 9- Joint classification (1 session)

Reference:

Dagnelie P. 2013. Theoretical and applied statistics. Volume 1. Descriptive statistics and the basis of statistical inference. *Brussels, De Boeck,* 517 p.

Tukey J. W.1953. "The Problem of Multiple Comparisons," Mimeographed Monograph, *Princeton University.*

Scheffé, H. 1953. A method for judging all contrasts in the analysis of variance, *Biometrika*, 40: 87 – 104. **Wayne, W. D. et Chad L.C., C. L. 2018**. Biostatistics: a foundation for analysis in the health sciences. *Wiley*.

Engineering title: marine biotechnology		
Semester : 2		
Title of the course: EMU Methodology 1 **Multidimensional Analysis and Digital Imaging**		
Title of subject 02: Workshop/stage1: Digital imaging		
Hourly volume: 37.5 H	**Credits: 03**	**Coefficients: 02**
Teaching objectives: The student will be able to design and model biomolecules of marine origin in three dimensions and prostheses (biomaterials), to follow by autocad 2020 and other tools, for example, tissue regeneration.		
Recommended prior knowledge: computer / office automation		
Autocad Computer-aided design and drafting / CAD/CAD/ Geomatics/ R,,, Program		

Engineering title: marine biotechnology		
Semester : 2		
Title of the course: Fundamental UEM2 Genetic Engineering		
Subject Heading 01: Genetic Engineering		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**

Teaching objectives:
This part of the material covers tools of molecular biology. The student must understand the principles of analysis techniques, select the appropriate method of analysis for a given problem, and be able to interpret the results obtained.

Recommended Prerequisites: Genetic, Molecular biology

Course (22.5 H)
I The tools of genetic engineering
I.1. Definition of Genetic Engineering
I.2. The basic tools of genetic engineering
I.2.1. Enzymes acting on nucleic acids
I.2.2. Vectors
II. Basic techniques in genetic engineering
II.1. Purification of nucleic acids
II.2. Nucleic acid separation techniques
II.3. Molecular hybridization
II.4. Selective amplification of DNA and RNA in vitro: PCR
II.5. DNA sequencing
II.6. Molecular cloning strategy
II.7. Other techniques:
II.7.1. Mutagenesis
II.7.2. Restriction fragment length polymorphism (RFLP)
II.7.3. Random amplification of polymorphic DNA (RAPD)
II.7.4. Application of genetic engineering (taxonomy)
Tutorials and practical work (Each tutorial will be done in two sessions)
The practical work will be carried out according to the availability of consumables

TD 1 : Restriction enzymes and their applications
TD 2 : Exercises on DNA purification and quantification
TD 3 : PCR and Sequencing Exercises
TD 4 : Exercises on mutagenesis
TP 1: DNA extraction
TP 2: purification and dosage of nucleic acids
TP 3 : Visualization of genomic DNA
TP4 : DNA amplification
TP5 : Enzymatic digestion
TP6: Introduction of DNA into a bacterial cell Evaluation method: Continuous monitoring, examination,

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 2</td></tr>
<tr><td colspan="3">Title of the course: UE Transversale UET1 Documentary research and communication</td></tr>
<tr><td colspan="3">Subject Title 01: Documentary Research and Communication</td></tr>
<tr><td>Hourly volume: 22.5 H</td><td>Credits: 01</td><td>Coefficients :01</td></tr>
<tr><td colspan="3">Teaching objectives:
The objective of this module is to teach the student the principles and rules of the scientific process. Teach him how to effectively carry out documentary research work in the university context by knowing the resources of the common documentation service, summarizing documents, writing a final thesis according to ISO standards... and master the oral presentation to present your presentation.</td></tr>
<tr><td colspan="3">Recommended prior knowledge: office automation</td></tr>
<tr><td colspan="3">Content of the subject: course (22.5H)
I. Research and exploitation of scientific documents 1.
Research Process:
- Define your needs
- Search documents
- Evaluating documents - Monitoring
2. Synthesis of scientific documents:
- How to synthesize scientific documents?
- Writing a reading report.
3. Written communication in research (Scientific and Technical Production): - Presentation of the various scientific documents (article, publication, dissertation, reports,...);
- Constituent parts of the different types of documents;
- Writing a thesis according to the ISO standard;
- Writing bibliographic references for all types of documents;

II. Oral communication in scientific research
- Rules of oral communication (preparation, message, support, posture, debate and answer to questions);
- Realization of a presentation (Posters, PPT, ...).</td></tr>
</table>

Engineering title: marine biotechnology		
Semester : S2		
Title of the course: UED Discovery		
Title of subject 01: Workshop/stage2: Activities related to the sea		
Hourly volume: 22.5 H	**Credits: 01**	**Coefficients: 01**

Teaching objectives:

Students will have to crisscross and discover in an interactive way the fauna, flora and the seabed through scuba diving. What will allow the creation of bonds between them, which represents an important social support, combined with the benefits of physical activity are all elements that promote the achievement of a life balance essential to student success. Students who will not be able to follow the diving training (for health or other reasons), trips to the coast, fishing port and fisheries, as well as an aquariology course are scheduled.

Workshop program:

Introduction to scuba diving: level P1

or Coastal outings, fisheries (fishmongers)/fishing port for the prospection of high value-added fishery products and by-products

/**Aquariology (setting up an Aquarium)**

Teaching objectives

Have a minimum knowledge of the principles of aquariology for the maintenance of aquatic organisms in an ornamental tank or pond. **Recommended Prior Knowledge**

Biology, Microbiology, cycles of the elements and physico-chemistry of water, zoology, botany.

Chapter I: Definitions and basic concepts

1. Aquariology
2. Aquariophilia
3. Breeding tank or aquarium
4. Etang
5. Aquascaping
6. The different types of breeding tanks
7. Nitrogen cycling and toxicity of bound nitrogen products
8. Other concepts

Chapter II: Aquarium equipment

1. Fresh water tank equipment
2. Pond equipment in aquarium keeping
3. Saltwater tank equipment
4. Aquascaping equipment

Chapter III: Species used in aquarium keeping

1. Freshwater species

2. Seawater species

Chapter IV: Pathology and Disease Prevention

1. The most common diseases in aquariums, causes and treatment
2. Water prophylaxis and treatment in aquariums

Chapter V: Practical Activities (12 H)

- Workshop for the assembly of an aquarium or an external pond (6 H) Visit to aquarium shops (6 H)

Evaluation method: left to the discretion of the training team.

References

- Breitenstein, Alain, 1999. *Aquarium keeping: the freshwater aquarium.* Paris: Proxima. 144 p.
- Gereg, Allain et al., 2009. *Larousse des poissons et aquariums: everything you need to know about freshwater and saltwater aquariums.* Paris: Larousse. 384 p.
- Hiscock, Peter, 2007. *The Encyclopedia of Aquarium Plants.* Paris: De Vecchi. 205 p.
- Mills, Dick et al., 2006. *Creating a marine aquarium: fish selection, layout, maintenance.* France: Marabout informatique. 208 p.
- Royer, Philippe and Stéphane Fournier, 2008. *Aquarium water treatment: freshwater, seawater, reef.* France: Animalia. 80 p.
- Vast, Claude, 2007. *The ABCs of the aquarium for everyone.* Paris: De Vecchi S. A. 96 p.

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

Semester : 3

Institution: ENSSMAL
Academic Year: 2023-2024

Program Title: Marine Biotechnology

Engineering title: marine biotechnology		
Semester : 3		
Title of the course: Fundamental UEF 1 Enzyme Engineering and Algae Biotechnology		
Title of subject 01: Enzyme engineering		
Hourly volume : 67.5 H	**Credits: 06**	**Coefficients: 03**

Teaching objectives:
The objective of this course is to present recent techniques for the research and engineering of enzymes and proteins, and their applications in the industrial and analytical fields, emphasizing the interest of these biocatalysts in a "green chemistry" approach and environmentally friendly processes.

Recommended Prerequisites: Biochemistry

Content of the subject: course (22.5 H)

Part I. Enzymology

1. Enzymatic kinetics. Michaelis–Menten equation

2. Concept of active site. Mechanism of action of enzymes

3. Modulations of enzymatic activity

3.1. Physicochemical properties of the medium

3.2. Ions and coenzymes

3.3. Competitive and non-competitive inhibitors

4. Non-Michaelian enzymes. Allostery

Part II. Enzyme engineering

1. Production and preparation of enzymes

1.1. Genetic aspects of enzyme production

1.2. Industrial enzyme preparations

1.3. Enzyme purification methods

1.4. Enzyme immobilization methods (retention of enzymes in an insoluble phase: support)

2. Industrial use of enzymes

2.1. Industrial applications of enzymes

2.2. Glucose-lsomerase

2.3. Penicillin-Amidase

3. Industrial enzymatic chemistry

3.1. production of organic acids

3.2. production of amino acids

4. Hygiene issues related to the use of enzymes

4.1. Choice of producing strains

4.2. Enzymes and the environment

4.3. Enzymes and diet

- Methods of immobilization of enzymes a) - Physical method: immobilization by adsorption

b) - Chemical method: immobilization by covalent fixation on a support.

c)- Applications in marine biotechnology (examples of marine enzymes) (1h30

VII. Industrial Enzyme Chemistry

a) Production of organic acids
b) Production of amino acids

VIII. Hygiene problems related to the use of enzymes

a) Choice of producing strains
b) Enzymes and the environment
c) Enzymes and Nutrition

TD/TP

TD1: Study of Michaelian kinetics (exercises: graphs to be drawn and kinetic parameters to be determined
TD2: effects of inhibitors on Michaelian kinetics (exercises: graphs to be drawn and kinetic parameters to be determined
TD3: Exercises on the different enzyme units (IU, Katal and AS) TD4: Kinetics with two substrates (exercises: graphs to be traced and parameters and mechanisms to be determined
TD5: effects of inhibitors on the kinetics with two substrates (exercises: graphs to be traced and parameters and mechanisms to be determined

Tutorial 6: Immobilization of enzymes by adsorption (Analysis of articles
Tutorial 7: Analysis of an article on enzymatic engineering (immobilization of enzymes by covalent bonding

TP1: Determination of the kinetic parameters of a Michaelian enzyme
TP2: Influence of temperature variation on enzymatic kinetics TP3: Influence of PH variation on the enzymatic reaction

Evaluation method: Continuous assessment, examination

Engineering title: marine biotechnology		
Semester : 3		
Title of the course: UEF Fundamentals Enzyme Engineering and Algae Biotechnology		
Subject Title 01: Marine Algae Biotechnology		
Hourly volume : 67.5 H	**Credits: 06**	**Coefficients: 03**
Teaching objectives: Develop genetic and biotechnological tools to study algae diversity and associated organisms; explore the exploitable fractions of these algae; promote algaculture and associated biotechnologies; acquire the latest conceptual and technological advances in algal biology and biotechnology; acquire skills to improve the quality of algal production and its processing.		
Recommended Prior Knowledge: Marine Plant Taxonomy, Marine Ecology		

Course Content (45 H):

I. Brief overview of marine algae (biology and diversity of microalgae and macroalgae)

II. Marine Microalgae Biotechnology

II.1. Isolation, identification and screening

II.2. Optimization of reproduction and growth cycles of algal cultures

II.3. Phytotechnics/algaculture (types of photobioreactors and production modes)

II.3.1. Biomass exploitation

II.3.2. Extraction, purification and characterization of biomolecules of interest

II.4. Industrial applications of microalgae: process flow diagrams

- Bioenergy and biofuels: biodiesel, bioethanol, biokerosene
- CO2 capture and greenhouse cultivation
- Human and animal nutrition (dietary supplements and functional foods: astaxanthins, carotenoids, phycocyanin, polyunsaturated fatty acids...)
- Water treatment

II.5. Metabolic and genetic improvement techniques

III. Marine Macroalgae Biotechnology

III.1. Harvesting techniques (algae harvesters and gatherers)

III.2. Marine macroalgae cultivation techniques: Biological material (seeds, plantlets): natural capture, cuttings, submerged and floating cultivation; Optimization of reproduction cycles of plantlets in hatchery-laboratory (free-living culture)

III.3. Marine macroalgae cultivation techniques

III.4. Overall chemical composition of marine algae

- Algae water (hydralixyr)
- Cell wall polysaccharides (phycocolloids): chemical structure, properties and applications (alginates, laminarins, fucoidans, carrageenans (kappa, lambda, iota), agars, ulvans...)
- Proteins, vitamins and minerals, lipids and pigments

III.5. Applications of algae and future developments

- Edible algae (uses in Europe, Far East...)
- Biomolecule applications
- Textile industry
- Agri-food industry (human and animal feed)
- Medical field (medicine-pharmacy) and cosmetics
- Paper industry
- Green chemistry industry (bioplastics...)

- Wastewater treatment (biosorption and removal of heavy metals)

- Other uses (fire resistance, highway edge stabilizer, agriculture, phytotherapy, hydrolysates as sources of trace elements and soil amendment for acidic lands...)

III.6. Quality control and marketing

Practical and Tutorial Work:

Practical work carried out depending on availability of live resources and equipment

TP 01: Determination of water content, dry matter and mineral content of marine algae

TP 02: Determination of total lipid content in marine algae

TP 03: Extraction and quantification of total soluble proteins in algae

TP 04: Extraction and quantification of phenolic compounds (Total Phenols) in green algae (Ulva)

TP 05: Extraction and quantification of sulfated polysaccharides in green algae (Ulva)

TP 06: Extraction of photosynthetic pigments from selected marine algae (micro and macroalgae) (in aqueous and solvent solutions)

TP 07: Separation and identification of photosynthetic pigments by column chromatography and spectral study (spectrum scanning from 400nm to 700nm) (4 chlorophyll pigments, phycocyanin, phycoerythrin, fucoxanthin...)

TP 08: Separation and identification of photosynthetic pigments by thin layer chromatography (TLC)

TP 09: Extraction and demonstration of iodine from brown marine algae

TP 10: Extraction of agar from red algae (Gelidium sesquipedale)

TD: Presentations on industrial applications of biomolecules (from raw material to finished product flow diagrams)

Evaluation Method:

Continuous assessment (50%), final exam (50%)

Engineering title: marine biotechnology

Semester : 3

Title of the course: Fundamental UEF 2 Cell culture and genetic improvement

Title of subject 01: Cell culture and genetic improvement

Hourly volume : 67.5 H	**Credits: 06**	**Coefficients: 03**

Teaching objectives: This subject will allow students to know and master the manipulation of animal cells from their culture to the genetic manipulation of living beings. Students will also have to discover the different applications of this animal biotechnology.

Recommended Prerequisites: Biology, Molecular Biology and Genetic Engineering 1 and 2

Content of the subject: course (45 H)

-Animal Cell Culture Techniques - Cells

- Normal cells
- Obtainment
- Cultivation
- Transplanting
- Transformed cells Culture media
- Containers - The environment
- Maintenance

I- Notions of embryology and reproductive biotechnology

1. Notions of embryology
2. Biotechnology in animal reproduction
3. Embryo biotechnologies

3.1 Classical embryonic biotechnologies

- Embryo transfer (ET)
- Embryo freezing
- In vitro fertilization (IVF)
- La maturation ovocytaire in vitro (MIV)

3.2 The embryonic biotechnologies of the future

- In vitro embryonic development (IVD)
- Embryonic sexing
- Embryonic cloning
- Transgenesis
- Production of transgenic marine organisms - Characterization of the transgenic marine organism

II- Breeding

- Cell hybridization
- Medical applications of the cell fusion technique

- Biotechnological application of transgenic organisms

III- I- In vitro vegetative propagation

1- In vitro culture technology

2- Micropropagation: meristem culture and sanitation, bud culture, adventitious organogenesis and regeneration 3- Somatic embryogenesis and artificial seeds

4- Isolated cell culture

II- Genome modification and plant breeding

1- Somaclonal variability and in vitro selection

2- Haplodiploidization: androgenesis and gynogenesis 3- Interspecific hybridizations and embryo rescue

4- Protoplast culture and fusion

5- Genetic engineering and plant transformation: transgenic plants

TUTORIALS :

- **TD 1** : Exercises on part I of the course and analysis of scientific articles.
- **Tutorial 2** : Exercises on part II of the course and analysis of scientific articles.
- **Tutorial 3** : Exercises on part III of the course and analysis of scientific articles.
- **Tutorial 4** : Exercises on part IV of the course and analysis of scientific articles.

Engineering title: marine biotechnology		
Semester : 3		
Title of the course: UEM Methodology 1 Bioinformatics and Process Engineering		
Subject Title 01: Bioinformatics and omics		
Hourly volume : 67.5H	**Credits: 05**	**Coefficients: 03**

Teaching objectives:
The objective of this course is to present the bioinformatics approaches that allow you to be autonomous in the conduct of a data analysis (e.g. taxonomy, phylogeny, prediction and analysis of DNA or protein sequences). It allows the analysis and comparison of results in databases as well as the mastery of tools that allow the study of functional and proteomic genomics.

Recommended Prior Knowledge: Molecular Biology and Genetic Engineering

Content of the subject: course (45 H)

1- Introduction
2- Tools for bioinformatics
2-1 Searching for biological information in public databases
2-2 Sequence analysis and comparison and gene prediction
2-3 Multiple sequence alignment
2-4 Phylogenetic analysis
2-5 Pattern and profile extraction
2-6 Protein sequence analysis, alignment and comparison
2-7 Prediction of protein structures
2-8 Whole genome analysis
2-9 Definition of oligonucleotide primers
2-10-Transcriptome Analysis
2-11- Proteomic Analysis

TD/TP:

- Numerical application of the different parts in the computer room - Analysis of articles
Part 2: Genomics and proteomics
General introduction to genomics and proteomics.
 Les projets de séquençage des génomes.
 Etude structurale des génomes et annotation : cartes et séquençage, les différents types de sequences, gene annotation (Northern blotting, RT-PCR, RACE, primer extension, RNase protection). Bases de données genomic sequences. Nucleic sequence alignment, pattern search.
 Techniques de génomique fonctionnelle : identification des gènes, recherche de la function, study of expression (SAGE method, DNA microarray method)
 Protéomique fonctionnelle: Post-translational modifications of proteins, functional groups, ...
 Protéomique analytique. : Electrophorèse 2D, isofocalisation, spectrométrie de masse,

microsequencing.
 Expression des protéines en systèmes cellulaires : Produc Recombinant proteins (Cell Culture, Western Blot), Biologically Active Peptide and Site-directed Mutagenesis
Marine genomics and proteomics

Tutorial: Analysis of articles on the applications of genomics and proteomics in the marine environment

Evaluation method: Continuous assessment 50% + exam 50%

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 3</td></tr>
<tr><td colspan="3">Title of the course: UEM Methodology 1 Bioinformatics and Process Engineering</td></tr>
<tr><td colspan="3">Title of subject 02: Unit operation: macroscopic balance</td></tr>
<tr><td>Hourly volume: 45 hours</td><td>Credits: 03</td><td>Coefficients: 02</td></tr>
<tr><td colspan="3">Teaching objectives:
The objective of this subject is to provide all the fundamental concepts for making material balances in order to size and model equipment for the various process engineering operations in order to develop new and more efficient processes or to optimize existing ones.</td></tr>
<tr><td colspan="3">Recommended prior knowledge: fluid mechanics, heat transfer and matter transfer</td></tr>
<tr><td colspan="3">Content of the subject: course (22.5 H)
Chapter 1: General information on unitary processes and determination of the degree of freedom.
Chapter 2: Material balance on unit processes
Chapter 3: Calculations on multi-unit processes (recycling and purging)
Chapter 4: Material balance in reacted processes Chapter 5: Energy
balance with and without reaction.
<u>TD</u>
SERIES 1: Determination of the degree of freedom
SERIES 2: Material balance on unit processes
SERIES 3: Calculations on multi-unit processes
SERIES 4: Material balance in reactive processes
SERIES 5: Material Balance in Reaction Processes</td></tr>
</table>

Engineering title: marine biotechnology		
Semester : 3		
Title of the course: UEM Methodology 1 Bioinformatics and Process Engineering		
Subject Title 03: Design of Experiments Methodology		
Hourly volume: 45 hours	**Credits: 03**	**Coefficients: 02**

Teaching objectives:
Know how to organize a series of tests using a design of experiments adapted to the objective of the experimental study.
Knowing how to carry out the statistical exploitation of the results of an experimental design.

Recommended prior knowledge: biostatistics, matrix analysis of data

Content of the subject: course (22.5 H)

I. Introduction

II. Historical

III. Definition and scope of design of experiments

IV. Vocabulary

IV.1. Factor

IV.2. Answers

IV.3. Experimental area and field of study

IV.4. Experience matrix

IV.5. Effect of a factor

IV.6. Interaction

IV.7. Mathematical model

V. Different types of design of experiments

V.1. Mixing plans

V.2. Screening Plans

V.2.1. Complete 2-level factorial designs

V.2.2. Two-tier fractional plans

V.2.3. Plackett-Burman's plans

V.3. Modeling plans

V.3.1. Doehlert's plans

V.3.2. Centered composite planes

V.3.3. Box-Behnken's plans

VI. Design of Experiments Software

VII. Analysis technique

VII.1. Analysis of variance

VII.2. Probability P

VII.3. Coefficients of determination (R2, R2 adjusted)

VII.4. Model validation

VII.5. Isoresponse curves and response surfaces

Tutorials

Tutorials

- TD1: Calculation of the coefficients of a 1st degree model
- TD2: Application of statistical tests for the validation of the 1st degree model
- TD3: Development of a 1st degree model
- TD4: Construction of a quadratic model based on a centered composite plane.

Engineering title: marine biotechnology		
Semester : 3		
Title of the course: UED Discovery Sustainable Development		
Title of the subject: Sustainable development		
Hourly volume: 3 p.m.	**Credits: 01**	**Coefficients: 01**
Teaching objectives: This course aims to enable students to obtain a global vision of the different social, economic, environmental and cultural dimensions of development as well as to understand their complexity. Students will gain knowledge about the concept of sustainable development and its implementation at different scales. Analysis and monitoring tools will also be discussed.		
Recommended prior knowledge:		

Content of the subject: course (15 H)

Introduction

- The current development model and its limitations.

II. History and definitions

III. Foundations and principles

IV. Evolution of the concept of sustainable development

- Key dates and conferences

V. Actors and tools of sustainable development

VI. The Sustainable Development Goals (SDGs)

- Background and characteristics
- The 17 SDGs
- The contributions of the SDGs
- SDG actors and their contribution - State of play of implementation

VII. Measuring sustainable development

- Indicators
- The ecological footprint
- Green GDP
- The Human Development Index (HDI)

Marine biotechnology and sustainable development

- Historical
- Challenges and priorities for sustainable development in the marine biotechnology sector IX. Resilience
- Definitions
- The importance of resilience
- Sustainable development and resilience

Evaluation method : End-of-semester exam (50%) and Continuous assessments: (50%)

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

Semester : 4

Institution: ENSSMAL
Academic Year: 2023-2024

Program Title: Marine Biotechnology

Engineering title: marine biotechnology		
Semester : 4		
Title of the Teaching Unit (UE): Fundamental – UEF 1: Microbial Biotechnology and Biopolymer Chemistry		
Subject Heading 01: Microbial Biotechnology		
Hourly volume : 67.5 H	**Credits: 06**	**Coefficients: 03**
Teaching objectives: This course addresses elements of biochemical engineering and industrial microbiology. It aims to provide students with operational skills in the use of microorganisms for industrial purposes, as well as in handling various types of bioreactors, including the		
Recommended Prerequisites **- General microbiology** **- Molecular biology** **- Genetic engineering**		

Course Content (45 hours)

Part I: Microbial Engineering

1. Overview of the microbial world and trophic types
2. Microbial growth kinetics and growth parameters
3. Metabolic pathways and their regulation:
   3.1. Primary metabolites (organic acids, amino acids, enzymes)
   3.2. Secondary metabolites (antibiotics, polysaccharides, biosurfactants…)
4. Improvement of metabolite production:
   4.1. Through genetic means: strain improvement
   4.2. Through metabolic pathway optimization
5. Fermentation Technology:
   5.1. Fermentation modes:
      - Batch fermentation
      - Fed-batch fermentation
      - Continuous fermentation (turbidostat, chemostat/bactogen)
      - Concentration gradient fermentation
      - Biomass recycling
6. General mass balance equations on reactor volume and applications to different types of reactors
7. Residence time distribution (RTD)
8. Fermentor hydrodynamics:
   - Power consumption
   - Reynolds number (Re)

Hydrodynamic regimes

   8.4. Flow in reactors (mixing phenomena, ideal flows, real flows)
9. Diagnosis of reactor function
10. Downstream processing and metabolite recovery (recycling, extraction, purification, and concentration)
11. Cultivation of microalgae in photobioreactors
12. Biomass production modes:
   - Pneumatic-stirred photobioreactors with external lighting
   - Bubble columns
   - Internally circulated photobioreactors
   - Internally lit photobioreactors
   - Horizontal growth chamber photobioreactors
13. Enzyme reactors (fixed-bed and fluidized-bed reactors)

Part II: Applications – Microbial Biomolecules

1. Microbial enzymes
2. Exopolysaccharides
3. Biosurfactants
4. Pharmaceuticals and antimicrobials

5. Marine biotoxins
6. Omega-3 (DHA and EPA) and Omega-6 fatty acids

Practical and Tutorial Program (Depending on Available Resources)

TD1: Review of bacterial growth and methods for determining growth parameters; exercises on bacterial growth
TD2: Study of trophic requirements (exercise session)
TP1: Enumeration techniques on solid media (surface and deep plating)
TP2: Enumeration on solid media using membrane filtration
TP3: Enumeration in liquid media (3-tube series method)
TP4: Enumeration using a Malassez counting chamber
TP5: Determination of the antibacterial activity of extracts from royal shrimp shells (pigments, chitosan) against E. coli, Enterococcus faecalis, and Staphylococcus aureus using the agar disk diffusion method
TP6: Batch culture of a bacterium and study of its growth

Assessment Method

Continuous assessment: 50%
Final exam: 50%

Engineering title: marine biotechnology		
Semester : 4		
Title of the course: Fundamental UEF 1 Microbial Biotechnology and Biopolymer Chemistry		
Material Title 02: Polymer Chemistry (Biopolymers)		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**

Teaching objectives: This subject aims to study the different types of polymers and particularly the bio-polymers that can be obtained by biotechnological techniques. To know their synthesis pathways and properties.

Recommended prior knowledge: Organic chemistry, biochemistry

Content of the subject: course (22.5 H)

- **Nature and structure of polymeric materials**
  - Natural and synthetic polymers;
  - Architecture ; -Characterization.
- **Different synthesis routes**
  - Chain polymerization;
  - Polycondensation;
  - Structure-property relationships.
- **Thermal and rheological properties of polymeric materials**
  - Amorphous polymers; - Semi-crystalline polymers; -Elastomers.
- **Complex polymer systems**
  - Polymer blend, plasticizers;
  - Copolymers;
  - Networks;
  - Fillers and composites; - Applications in biology.
- **Formulation of polymers in solution**
  - Thickeners;
  - Encapsulation of active ingredients in colloidal structures;
  - Gels.

TP/TD

TP: Manufacturing a biodegradable polymer from marine resources **TP:** Manufacturing a synthetic polymer based on starch and nylon

Tutorial: series of exercises

Engineering title: marine biotechnology		
Semester: 4 Immunotechnology and Valorization of Biomolecules of Animal Origin		
Title of the course: Fundamental UEF 2		
Subject Title 01: Immunology and Immunotechnology		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**

Teaching objectives:
This subject aims to give general notions of immunology and to teach students the use of the properties of immune responses, antibodies and immunological techniques in various fields of research, control, biomedical analysis and biotechnological production.

Recommended prior knowledge: general biology, biochemistry, genetic engineering

Content of the subject: course (H)

Introduction to Immunology

- Notion of antigen
- Roles and properties of the immune system

Immune organs and cells

- Lymphoid organs: location, structure and function
- The different immune cells: morphology, function, differentiation markers
- The circulation of immune cells

Innate immunity

- Natural barriers
- The inflammatory reaction

Adaptive immunity

- Properties: notion of specificity, diversity and memory, application to vaccination and serotherapy
- The stages of the response: activation, proliferation, differentiation
- The effector step

Monoclonal and recombinant antibodies

- Principle of obtaining
- Combinatorial antibody libraries and peptide libraries
- Application

Engineering title: marine biotechnology		
Semester : 4		
Title of the course: Fundamental UEF 2 Immunotechnology and Valorization of Biomolecules of Animal Origin		
Course Title 02: Valorization of Animal-Derived Biomolecules		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**
Recommended Prerequisites: Biochemistry, marine animal biodiversity, marine physiology and ecophysiology, instrumental analysis techniques		

Course Content

1. Economic importance of marine biotechnology and animal-derived molecules

2. Biomolecules from invertebrates: extraction, purification, and characterization

2.1. Fatty acids from sponges

2.2. Biomolecules from crustaceans:

- Chitin, chitosan, and derivatives

- Pigments (astaxanthin, carotenoids)

- Omega-3 fatty acids

- Peptides (enzymes and flavor compounds)

- Minerals

2.3. Biocatalysts from Aplysia

2.4. Biomolecules from echinoderms (e.g., saponins)

2.5. Glucosamines and Chondroitin Sulfate

2.6. Biomolecules from mollusks (calcium carbonates, minerals, peptone, marine collagen, gelatin, etc.)

2.7. Biomolecules from polychaetes: blood from Arenicola and adhesive secretions from Sabellaria (sandcastle worm)

3. Biomolecules from Vertebrates: Extraction, Purification, and Characterization

- Enzymatic ensiling (hydrolysates for flavors and aromas)

- Chemical ensiling (omega-3-rich fatty acids and lipids)

- Biomolecules from Rajidae and Squalidae: Glycosaminoglycans (chondroitin sulfate, dermatan sulfate, keratan sulfate, heparin/heparan sulfate, hyaluronic acid)

4. Main Applications of Animal-Derived Biomolecules

- Human Nutrition: Dietary ingredients and nutraceuticals: mineral supplements, marine lecithins

- Animal Feed: Fishmeal and fish oils

- Cosmetic Ingredients: Collagen, keratin, squalene, elastin, pigments

- Active Biomolecules and Pharmaceutical Applications: Biomaterials, antioxidants, anti-inflammatories, anticoagulants, antiplatelet agents, antitumor agents, wound healing agents, antivirals

- Water Treatment: Biosorbents and adsorbents, antagonistic agents

Practical Work

Lab Session 1: Preparation of acid ensilage from fish by-products

Lab Session 2: Characterization of the composition of fish oil from acid ensilage using thin-layer chromatography (TLC)
Lab Session 3: Quality assessment of fish oils produced (peroxide value and acid value)
Lab Session 4: Extraction of chitin from shrimp shells
Lab Session 5: Deacetylation of chitin and production of chitosan
Lab Session 7: Extraction of marine collagen from fish skins (e.g., sole)
Lab Session 8: Determination of the antimicrobial activity of produced biomolecules using the agar well diffusion method
Lab Session 9: Extraction of pigments (astaxanthin) from shrimp shells
Lab Session 10: Purification and characterization of produced pigments (astaxanthin) using column chromatography, spectral analysis, and TLC

Engineering title: marine biotechnology		
Semester : 4		
Title of the EU: EMU Methodology 1 Biomarkers in Marine Ecotoxicology		
Subject Title 01: Biomarkers/ biomonitoring		
Hourly volume: 45 hours	**Credits: 03**	**Coefficients: 02**

Teaching objectives:
Participate in marine and coastal biomonitoring through molecular diagnostics and analyses (early/exposure biomarkers and damage biomarkers)

Recommended prior knowledge: general biochemistry, pollution, marine ecology and marine ecophysiology

Content of the subject: course (H)

I. Pollution characterization and marine ecotoxicology

I.1 Definitions and Purpose of Ecotoxicology
I.2 Main types of contaminants (physical, chemical and biological)
I.3 Functional classification of chemical pollutants (degradable, dissipative, particulate and preservative)
I.4 The influence of the physicochemical properties of toxic compounds on the rate and extent of absorption
I.5 Degradation and metabolization of micropollutants
I.6 Trophic transfer of chemical compounds

II. Pollutant monitoring

II.1Concept and Use of Environmental Quality Bioindicators

- *Definitions*
- *Concept of an ideal bio-monitoring strategy and Legal background*

II.2 Accumulation of contaminants in organisms

II.2.1 Toxicity Tests and Detection Methods: Advantages and Disadvantages of Measurements in Water, Sediment (Soil) and Organisms (*New Aquatic Ecotoxicity Tests)*

II.2.2 The ideal bioaccumulators

II.3 Biomarkers

II.3.1 Definitions: effect, exposure, specific, non-specific markers

II.3.2 Non-specific morphological, physiological and biochemical markers

II.3.2.1 Growth
11.3.2.2 Energy activity *Metabolic energy*
Energy reserves
Enzymes of energy metabolism
The energy of growth and reproduction
II.3.2.3 Endocrine activity

II.3.2.4 The immune response
II.3.2.5 The detoxification function (phase II)
II.3.2.6 Response to oxidation
II.3.2.7 Constituent proteins and enzymes
Proteins, biomarkers of stress
La Na +IK+ -ATPase
II.3.2.5 Blood chemistry
Case study:
Imposex in marine gastropods
Malformation in turbot
Effect of TBT on Mytilus edulis SFG
Effect of oil pollution on the Macrocystis banks
Toxicity of PAHs to larval development in salmon
Abnormality in halibut embryonic development due to heavy oils
II.5 Specific biochemical markers
II.5.1 The MFO Detoxification Enzyme System
Flavin monooxygenases
Cytochrome P450
II.5.2 Acetylcholinesterase
II.5.3 δ-Aminolevulinic Acid Dehydratase (Δ-AIAD)
II.5.4 Metallothioneins
II.5.5 Genotoxicity markers
II.5.5.1 Chromosomal aberrations
II.5.5.2 DNA adducts (*The role of adducts in the process of carcinogenesis)* Inhibition of DNA methylation
II.5.5.3 Transfers
Experimental carcinogenesis in fish
Neoplastic lesions and tumors observed in situ
II.6 Biological effects at the population level and Ecological indicators <u>TP/TD</u> :
Tutorial 1: Biomarker-marine environment relationships
TD 2: Process of insertion of pollutants in food webs:
Lab 1: Daphnia magna *mobility inhibition test*
Lab 2: Ames Test
TP 3 : Determination of the LD50 and LC50 of a toxic substance in mice **TP 4** : Comet test
TP 5 : Test micronucleus

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 4</td></tr>
<tr><td colspan="3">Title of the course: EMU Methodology 2
Entrepreneurship, Business Management and Professional Integration</td></tr>
<tr><td colspan="3">Subject Title 01: Internship in a company and Professional integration</td></tr>
<tr><td>Hourly volume: 60 hours</td><td>Credits: 05</td><td>Coefficients: 03</td></tr>
<tr><td colspan="3">Teaching objectives: The objective of this internship is to apply the knowledge acquired to address a biotechnological problem or master biotechnology tools and to acquire other methodological, organizational or communication skills.</td></tr>
<tr><td colspan="3">Recommended prior knowledge: UE of semesters 5, 6 and 7</td></tr>
<tr><td colspan="3">Content of the subject: course (60 H)
An integration internship of 15 working days (60 hours) in an organization (company, laboratory, other) is planned for this semester. Evaluation method: the teaching team will decide on the evaluation, which will be based on an internship report and a presentation</td></tr>
</table>

Engineering title: marine biotechnology		
Semester : 4		
Title of the course: EMU Methodology 2 **Entrepreneurship, Business Management and Professional Integration**		
Subject Title 02: Entrepreneurship and Business Management		
Hourly volume: 45 hours	**Credits: 03**	**Coefficients: 02**
The objectives of the course are to teach the student the tools of management and to train him on decision-making, allowing him to acquire the skills of a manager.		
Content of the subject: course (22.5 H) **Chapter I: Entrepreneurial logics and corporate social responsibility** 1.1. Global approach to entrepreneurship 1.2. Strategic and operational management 1.3. Strategic intelligence and economic intelligence 1.4. Ethics, Respect for the Environment and Commitment **Chapter II: Management of the company** 2.1. Management of the company's administrative and financial function 2.1.1. Financial strategy and analysis 2.1.2. Management control and budgetary audit 2.1.3. Corporate tax strategy 2.2. Human resources management 2.2.1. Team management 2.2.2. Recruitment and remuneration policy 2.2.3. Human Resources Development 2.2.4. Management of social relations 2.3. Management of the sales and marketing function 2.3.1. Marketing strategy 2.3.2. Business Strategy 2.3.3. Internal/external communication policy 2.4. Operations management 2.4.1. Purchasing Policy 2.4.2. Production management 2.4. 3. Quality certification **Tutorials:** Exercises, Presentations, Case Studies.		

Engineering title: marine biotechnology		
Semester : 4		
Title of the course: Transversale UET Entrepreneurship, Business Management and Professional Integration		
Subject Title 02: Subject Title 01: English for Specific Purpose (ESP)		
Hourly volume: 22.5 hours	**Credits: 01**	**Coefficients: 01**
The objectives of the course This program is intended for future engineers to allow them to acquire basic knowledge of the English language, in order to be able to analyze a corpus containing key words, or scientific terminology. A scientific document is a text that contains scientific terms, written in a clear and concise style. The student must master linguistic tools to be able to understand the objective of a scientific text. The program consists of four (04) units, each of which contains a set of basic grammar knowledge, vocabulary related to a scientific theme, which will be developed by personal research by the student as preparation for an oral presentation. Each unit is followed by a series of exercises and a lexicon relating to the theme. **Recommended Prerequisites:** English (Units 1,2.3 and 4)		

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
National Higher School of Marine Sciences and Coastal Management
Specialization: Marine Biotechnology

Semester : 5

Institution: ENSSMAL
Academic Year: 2023-2024

Program Title: Marine Biotechnology

Engineering title: marine biotechnology		
Semester : 5		
Title of the course: Fundamental UEF 1		
Title of subject 01: Bioprocesses for decontamination and bioremediation in the marine environment		
Hourly volume: 68 hours	**Credits: 06**	**Coefficients: 03**
Teaching objectives: This subject is devoted to the description of the modalities of biodegradation (under the mediation of microorganisms) of organic molecules artificially introduced into the marine environment: domestic (detergents) and industrial effluents (aromatic rings and halogenated molecules), hydrocarbons and plastics. The student must be able to search for or select microbial populations likely to degrade contaminants of biotic or abiotic origin in order to implement biological treatments.		
Recommended prior knowledge: pollution; general microbiology, process engineering, microbial biotechnology.		

Content of the subject: course (22.5 H)

1. Reminder of the different types of pollution, pollution parameters, fate and consequence of pollution

2. Bioremediation by microorganisms

2.1 Introduction
2.1.1 Specificity and non-specificity
2.1.2 Microbial adaptation to the degradation of pollutants
2.1.2.1 Lower and upper thresholds
2.1.2.2 Adaptation and latency phase
2.1.2.3 Successive synergies and degradations
2.2 Microbial mechanisms of bioremediation
.2.1 Mineralization
2.2.2 Cometabolism
2.2.3 Detoxifying transformations
2.2.3.1 Hydrolysis
2.2.3.2 Hydroxylation
2.2.3.3 Dehalogenation
2.2.3.4 Demethylation and Other Dealkylations
2.2.3.5 Methylation
2.2.3.6 Reduction of a NO2 function
.2.3.7 Deamination
2.6.2.3.8 Cleavage of an ether bond (C-O-C)
2.2.3.9 Conversion of a nitrile to amide
2.2.3.10 Conjugation
2.2.3.11 Ring opening (benzene compounds) 2.2.3.12 Multiple reactions

2.2.3.13 Non-Detoxifying Transformations
2.3.2.4 Bioconcentration
2.3 Environmental parameters that affect biopollution

3. Methods for measuring and checking biodegradability
3.1 Parameters of organic water pollution (BOD, COD, pH, TSS, etc.).
3.2 Physicochemical and biotic factors controlling biodegradability in the marine environment
3.4 Analysis of the inherent biodegradability of substances by Zahn-Wellens tests
- Rules of thumb for the biodegradability of substances
- Principle and objectives of the method according to the standard
- Main steps in testing and calculating biodegradability rates - Interpretation of biodegradability curves

4. Applications of environmental biotechnologies
4.1 Biomonitoring and bioindicators
4.2 Bioremediation of hydrocarbons in the marine environment (Natural attenuation, biostimulation, Bioaugmentation)
4.3 Biosurfactants and Bacterial Oil Capture
4.4 Combined techniques for the mechanical, physico-chemical and biological remediation of oil spills
4.5 Biotransformation and bioaccumulation of metal compounds
4.6 Wastewater treatment plant and biological treatment of wastewater.
4.7 Scientific watch on innovative and hybrid bioprocesses for depollution

Practical work/tutorial/field trip

TP: Measurement of organic pollution parameters (BOD5, COD, TSS, pH) **TP:**
Zahn Wellens' inherent biodegradability tests

TD: BOD5 and Easy Biodegradability Ratio Calculations of Effluents

Case study: Interpretation of calculation results and curves of inherent biodegradability according to Zahn-Wellens tests. The case of industrial effluents in the fine chemicals sector.
Field trip/Case study: Performance evaluation of decontamination processes
a wastewater treatment plant (WWTP).
Field trip/Case study: Performance evaluation of simple and hybrid bioprocesses for the depollution of industrial effluents in coastal areas.

Engineering title: marine biotechnology		
Semester : 5		
Title of the course: Fundamental UEF 1 **Biocorrosion, anti-fouling and biotechnological decontamination processes**		
Material Title 02: Biocorrosion and Anti-Fouling		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**
Teaching objectives: This part allows students to understand the phenomena of biodeterioration of structures, particularly cements and concretes, and the alteration of metal structures in order to be able to remedy them.		
Recommended prior knowledge: chemistry,		
Content of the subject: course (45 H) **Content of the subject Courses** **1-Basic in Electrochemistry** 1-1- Electrochemical reaction 1-1-1- Electrochemical Cell 1-1-2- Load transfer 1-1-3-Mass Transfer 1-1- 4-Double-Layer 1-5- Electrode Kinetics 2- **Electrochemistry and corrosion** 2-1- Definition of corrosion 2-2- different types of corrosion (galvanic, pitting, crevice, erosion 2-3- Corrosion study and measurement 3- **Biodegradation of materials and biocorrosion** 3-1- Microbial growth on a biofilm-forming surface 3-2- Microorganisms and corrosion: case studies and mechanisms 3-2-1- Aerobic conditions: iron, manganese, etc. 3-2-2- Anaerobic conditions: sulphate-reducing bacteria 3-2- 3-Effect of biofilm (biofouling) on the corrosion surface 3-3- Biofouling and corrosion monitoring 3-4- Biocorrosion and biofouling: from control to prevention **TD:** Marine Corrosion and Biofuling Case Study Presentations on corrosion and antifouling methods Method of evaluation: continuous assessment (50%) + examination (50%)		

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 5</td></tr>
<tr><td colspan="3">Title of the course: Fundamental UEF 2 Economics and Project Management</td></tr>
<tr><td colspan="3">Subject Title 01: Economics of the Marine Environment</td></tr>
<tr><td>Hourly volume: 45 hours</td><td>Credits: 04</td><td>Coefficients: 02</td></tr>
<tr><td colspan="3">Teaching objectives : The objective of this module is to provide fundamental benchmarks in environmental economics, in particular, to apply economic principles to public policies on the environment and to the management of natural resources. Focus on economic analyses of impacts and cost/benefits.</td></tr>
<tr><td colspan="3">Content of the subject: Courses (H) Courses
<u>Content of the educational program</u>
Chapter I: Introduction to the general economy
1.1. Purpose of economic science
1.2. The main currents of economic thought
1.3. The economic circuit
1.4.Economic functions
1.5. Models of economic organization

Chapter II: Economics of the Marine Environment
2.1. Interaction between the economy and the natural environment
2.2. Natural Resources and Economic System
2.3. Environmental Assets and Market Failure:
2.3.1. Property rights and the dimension of the common good, the public good of the environment
2.3.2. Externalities in the marine environment
2.3.3. Theory of well-being (Pareto's optimum)
2.4. Marine environmental regulation policies
2.4.1. Negotiation
2.4.2. Regulatory instrument (standards, taxes, subsidies, etc.).

Chapter III: Blue economy and social and solidarity economy
3.1. Concepts and applications

<u>Tutorials:</u> Exercises, presentations, ...</td></tr>
</table>

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 5</td></tr>
<tr><td colspan="3">Title of the course: Fundamental UEF 2 Economics and Project Management</td></tr>
<tr><td colspan="3">Subject Title 02: Project Management</td></tr>
<tr><td>Hourly volume: 45 hours</td><td>Credits: 04</td><td>Coefficients: 02</td></tr>
<tr><td colspan="3">Teaching objectives: The objective of this module is to make the student understand the basics of project management and master the organization to start a project. It allows them to know the skills of project management, to assess and anticipate risks, to master the actors and bodies of a project, to understand the roles and responsibilities in the project environment and also to lead a project team.</td></tr>
<tr><td colspan="3">Recommended prior knowledge:</td></tr>
<tr><td colspan="3">Content of the subject: course (H)
Chapter I: Project formalization
- Definitions and Typology
- The seven facets of project management
- Project lifecycle

Chapter II: General approach to project management -
Project organization
• Perimeter
• Teams
• Tasks and responsibility
• Project stakeholders
• SWOT Matrix
- Project Planning
• GANTT chart, PERT
• Financial Management
• Risk and Opportunity Management - Project management
• Asset Tracking
• Steering indicator
• Quality approach
- Project communication
• Means of communication
• Communication Plan

Chapter III: Technical and economic project studies
- Case studies
<u>Tutorials:</u> Exercises, presentations...</td></tr>
</table>

Engineering title: marine biotechnology		
Semester : 05		
Title of the course: EMU Methodology 1 Quality Control Techniques		
Subject Heading 01: Microbial Control Techniques		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**
Teaching objectives: The objective of this part is to master microbiological techniques for the control of pharmaceutical or food products.		
Recommended Prior Knowledge: General Microbiology		

Content of the subject: course (22.5 H)

Introduction

1. Objectives of microbiological control.
- Qualité hygiénique.
- Qualité technologique.

2. Control Policy.
- Les niveaux de contrôle.
- La fréquence des contrôles.
- Les paramètres à contrôler.
- Les méthodes de contrôle.

3. Sample collection, transport and preparation.
- Cas des échantillons solides.
- Cas des échantillons liquides.
- Echantillonnage en surface.
- Techniques de dilution.

4. Classic numeration techniques.
- Numération microscopique.
- Numération en milieu solide.
- Numération en milieu liquid.

5. Recent numeration techniques.
- Spectroscopiques.
- Electrochimique.
- Autres procédés (chromatoghraphie, Microcalorimétrie…..)

6. Germ identification.
- Caractères morphologiques et structuraux.
- Cultivation characteristics.
- Caractères biochimiques et physiologiques.
- Caractères immunologiques.
- Pouvoir pathogène.

7. Carrying out the control.
- Contrôle des matières premières.
- Contrôle de la fabrication.
- Contrôle de nettoyage et de la désinfection.

 ConFinished products.

TD/TP
Tutorials and practical work will be planned according to the program and the means available.

TP: Microbiological control of products (food, medicines, etc.)

Evaluation method: Continuous assessment (50%), examination (50%)

Engineering title: marine biotechnology		
Semester : 05		
Title of the course: EMU Methodology 1 Quality Control Techniques		
Title of subject 02: Toxicological-pharmacological controls		
Hourly volume: 45 hours	**Credits: 04**	**Coefficients: 02**

Teaching objectives: The objective of the course is to acquire basic notions in pharmacology and toxicology. The pharmacology part will emphasize the basics of understanding the pharmacokinetics and fate of drugs in the body and the general principles of pharmacodynamics (dose-response relationships, mechanisms of action). While the toxicology part will mainly insist on the explanation of the main mechanisms of action of toxicants and on the description of some examples and some analytical tests.

Recommended prior knowledge: chemistry, biochemistry, biomarkus/biomonitoring

Content of the subject: course (22.5 H) Part 1.
Pharmacology:

1. Introduction to General Pharmacology and Drug Use
2. Pharmacodynamics: Basics of Drug Effects

2.1. Mechanism of action of the active ingredients
2.2. Quantification of effects: dose/effect relationships, concentration/response
2.3. Biopharmacy: influence of the galenic form, the excipients and the route of administration on the absorption of the active ingredient; Concept of bioavailability and bioequivalence

3. Pharmacokinetics: study of the different stages of the fate of an active ingredient in the body 3.1. Absorption

3.2. Distribution
3.3. Metabolism
3.4. Elimination

4. Active molecule discovery phase (clinical study)

5- Activity Testing
5-1- Analgesic activity tests
5-2- Parasympatholytic activity tests
5-3- Spasmolytic activity tests
5-4- Anti-inflammatory activity tests
5-5- Diuretic activity tests
5-6- Anti-infective activity tests (antibiotic, antiviral, antifungal)

6- Technological tools for the identification of molecules of therapeutic interest
6-1- Bioinformatics applied to pharmaceutical research
6-2- Combinatorial chemistry
6-3- Drug Design

Part 2: Toxicology

1. Toxicology (Definitions, concept of dose, dose-effect relationship, classes of toxicants: Drugs, drugs, food toxicants, agri-food toxicants, toxins, chemicals, combustion products, etc.)
2. General Principles of Toxicology

2.1. Forms of poisoning (Aigue, sub-acute and chronic)

2.2. Factors Influencing the Body's Response to a Toxic

- Physical-chemical properties of the substance
- experimental (bioavailability), biological (age, sex) and environmental factors 3. Dynamics of the toxic in the body:

3.1- Absorption, Distribution, Fixation and Storage of the Toxicant

3.2- Biotransformation of the Toxicants:

- Phase I (Oxidation, Reduction, Hydrolysis), Phase II (Conjugation) - Bioactivation and Excretion of Toxicants

4. Target Organ Physiology and Toxicology -
Liver, Gastrointestinal and Kidney Toxicology
5. In vitro toxicology: analytical tests
6. Genotoxicology, Carcinogenesis and Mutagenesis
7. Main toxicants of food and medicines:

7.1- Natural harmful substances in food (anti-nutritive substances, biogenic amines)

7.2- Chemical Contaminants in Food and Drugs - Food Additives, Pesticide Residues, Heavy Metals,

7.3- Microbial Contaminants

Practical/Tutorials:

1. Toxicological evaluation (LD50, LC50, TL50, etc.)
2. Determination of the ADI, MRL 3. The choice of biological media in relation to the toxic ones analysed (biological media). 4. Article analysis

Engineering title: marine biotechnology		
Semester : 05		
Title of the EU: EMU Methodology 2 Bioethics, Innovation and Intellectual Property		
Subject Title 01: Bioethics/Biosafety		
Hourly volume: 22.5 H	**Credits: 01**	**Coefficients: 01**
Teaching objectives: To raise students' awareness of the problems related to the development of technologies in the Life Sciences and their impact on health, safety and the environment, by identifying risk assessment approaches and presenting standards and legislation as well as ethical issues. Without forgetting to remind you of the safety measures taken at the laboratory.		
Recommended prior knowledge: none		

Content of the subject: course (H) Course programme:

I. Bioethics

1. Definitions
2. Historical Background
3. International legislation II. The risks

1. Toxic products
2. Biological weapons
3. GMOs

III. Biosecurity

1. Definition and Background
2. Risk Analysis IV. HSE in the laboratory

TD Program:

- Processing of thematic articles.
- Debates around thematic videos
- Keynote presentations

Engineering title: marine biotechnology		
Semester : 05		
Title of the EU: EMU Methodology 2 Bioethics, Innovation and Intellectual Property		
Topic Title 02: Innovation and Intellectual Property		
Hourly volume: 22.5 H	**Credits: 01**	**Coefficients: 01**

Teaching objectives: The objective of this subject is to allow the student to understand the current challenges of companies and how to position themselves in an environment of innovation and integrate creativity into daily life. Also, learn the appropriate tools for the protection of one's creation.

Content of the subject: course (22.5 H)

1. Innovation in the company

- 1.Definitions
  - The link between creativity and innovation
  - Why innovate?
  - How to encourage innovation
  - The foundations of anticipation in innovation
  - Alternatives in terms of innovation
  - The risks of innovation
- **Generating innovative ideas**

2.1.Setting up an innovation process

2. Stimulate individual creativity
  - Stimulating organizational creativity
  - Turning ideas into innovation concepts
  - Diffuser l'innovation

2.6.Protecting and enhancing innovation

Chapter II: Intellectual Property

Definition and purpose of Intellectual Property:

- Legal context
- The administrative institutions responsible for protection:

Creation Protection

- Industrial property

- Patents

- Brands

- Industrial designs

- Geographical indications

Plant varieties
2.2. Literary and artistic property
Copyright Other distinguishing features
3. Defense of intellectual property rights Assessment mode: Continuous assessment (50%) + EMD (50%)

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 5</td></tr>
<tr><td colspan="3">EU Title: Transversal ETU 1 English and the Law of the Sea</td></tr>
<tr><td colspan="3">Title of subject 01: Law of the sea and the marine environment</td></tr>
<tr><td>Hourly volume: 22.5 H</td><td>Credits: 01</td><td>Coefficients: 01</td></tr>
<tr><td colspan="3">Objectives of the course: the legal regimes applicable to the various maritime areas defined by international law are discussed, as well as the main international conventions aimed at regulating the pollution of maritime spaces; those devoted to the management of marine biological resources. It also aims to broaden students' vision of the political aspect in the field of fisheries, maritime transport and the protection of the marine environment.</td></tr>
<tr><td colspan="3">Recommended prior knowledge: none</td></tr>
<tr><td colspan="3">Content of the subject: course (22.5 H)
I. General
II. Law of the Sea
1. Definitions
2. Developments
3. Deformations
4. United Nations Convention for the Law of the Sea (Montego Convention Bay)
III. Environmental Law
1. Definition
2. Intervention
3. International conventions and/or protocols
4. Environmental Law in Algeria
5. Examples of international conventions and/or protocols:
- Barcelona Convention for the Protection of the Mediterranean -
Rio Convention for Biological Diversity:
▪ Cartagena Protocol on Biosafety
▪ Nagoya Protocol on Access and Benefit-sharing of Genetic Resources</td></tr>
</table>

<table>
<tr><td colspan="3">Engineering title: marine biotechnology</td></tr>
<tr><td colspan="3">Semester : 5</td></tr>
<tr><td colspan="3">EU Title: Transversal ETU 1 English and the Law of the Sea</td></tr>
<tr><td colspan="3">Subject Title 02: English for Specific Purpose (ESP)</td></tr>
<tr><td>Hourly volume: 15h</td><td>Credits: 01</td><td>Coefficients: 01</td></tr>
<tr><td colspan="3">Teaching objectives: This program is intended for future engineers to allow them to acquire basic knowledge of the English language, in order to be able to analyze a corpus containing key words, or scientific terminology. A scientific document is a text that contains scientific terms, written in a clear and concise style. The student must master linguistic tools to be able to understand the objective of a scientific text. The program consists of twelve (12) units, each of which contains a set of basic grammar knowledge, vocabulary related to a scientific theme, which will be developed by personal research by the student in preparation for an oral presentation. Each unit is followed by a series of exercises and a lexicon relating to the theme.</td></tr>
<tr><td colspan="3">Recommended prerequisites: English (S4), English (S1)</td></tr>
<tr><td colspan="3">Content of the subject: course (H)
Unit 9 : Writing reports
Unit 10 : Application Forms
Unit 11 : Preparing CV’s
Unit 12 : Oral Interviews and Tips
-Questions and answers
-Play role activities for sudents References :
- Bates Martin, Dudley-EvansTony, Nucleus : English for science and technology, UK :Longman, 1995.
- Cristal David, The Cambridge Encyclopedia of English Language, USA : Cambridge University Press, 1999.
- Kelly Keith, Science, Macmillan Vocabulary Practice Series, 2008.
- McCarthy Michael, O’Dell Felicity, English Vocabulary in use,Cambridge University Press, 1996.
- Paquette Anne, Roehner Bertrand, Science in English, 1997.
- Stockwell, R., Minkova, D., English Words : History and structure, UK :University Press of Cambridge, 2001.
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</table>