PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
FERHAT ABBAS UNIVERSITY, SETIF 1
FACULTY OF NATURAL AND LIFE SCIENCES

DEPARTMENT OF BASIC STUDIES

Polycopy of Tutorial works

Designed For second year students (LMD)

FIELD: Natural and Life Sciences (NLS)

SECTOR: Biological Sciences

«General Ecology »

Discovered Teaching Unit

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Modul: General Ecology

Semester: 4th Semester

Teaching Unit: Discovery

Code: UED 2.2.1

Credits: 2

Coefficients: 2

Tutorial Description: This tutorial provides the students with a basic understanding of ecological principles. Multiple levels of ecological organization will be examined including: populations, communities and ecosystems, interactions of living organisms and the physical environment, inter- and intraspecific relationships, energy flow and applications to current environmental issues.

Methodology: The methodology of teaching ecology is based on State Educational Canvas (Educational program) adopted by the Ministry of Higher Education and Scientific Research.

To understanding the questions that ecologist's study, the methods they use, and the questions that remain unanswered and to acquire a broad knowledge of ecological systems and understand the influence of biotic and abiotic environments on ecosystem state, **we utilize** for Each chapter a process (worksheet) that involve students to observed, measured, classified, experimented, calculates, plots and analyzes several parameters and criteria based on equations and diagrams. These worksheets assist students in understanding, discussing, inferring, predicting and interpreting data about environmental issues.

Content of the Matter:

Chapter I:

1.1. Definition of the ecosystem and its constituents (Notions of biocenosis and ecological factor).

1.2. Areas of Intervention.

Chapter II: The factors of the environment.

2.3. Interaction of environments and biocenosis.

2.3.1. Role of ecological factors in population regulation.

2.3.2. Concept of ecological optimum.

2.3.3. Ecological Valence.

2.3.4. Ecological niche.

Chapter III Abiotic factors.

3.1 Climatic factors.

3.2 Edaphic factors.

Chapter IV: Biotic factors.

4.1. Competitions.

4.2. Pests and Predators.

4.3. Interaction of cooperation and symbiosis.

4.4. Parasitism.

Chapter V: Structure of ecosystems and functioning of ecosystems.

5.1. Structure of food chains; relationships between producers (autotrophs) and their dependence on nutrients and light or chemical energy.

5.2. Consumers (Heterotrophs) who are related to producers and finally decomposers that ensure the recycling and mineralization of organic matter.

Chapter VI: Energy flows and the concept of productivity

6.1. Energy flows at the biosphere level:

6.2. Concepts of ecological pyramids, production, productivity and bioenergy efficiency.

6.3. Movement of matter in ecosystems and major bio- geochemical cycles.

6.4. Influence of human activities on biological balances and particularly on the disturbance of bio-geochemical cycles (consequences of pollution of aquatic environments and air pollution (eutrophication, greenhouse effect, ozone, acid rain.).

Chapter VII: Brief description of the main eco-systems.

7.1. Forest, grassland, surface water, ocean.

7.2. Evolution of ecosystems and concept of climax.

Tutorial works:

Tutorial works include the methods applied for the study of the environment.

Mode of evaluation:

Continuous assessment (a final examination at the end of the tutorial works).

Tutorial Works Program:

TW N 1: BASIC CONCEPTS IN ECOLOGY AND FIELDS OF APPLICATION: (Chapter I).

TW N 2: INTERACTION OF ENVIRONMENTS AND BIOCENOSIS. (Chapter II):

TW N 3: ABIOTIC FACTORS (Chapter III):

TW N 4: CLIMATIC FACTORS (Bioclimatic Analysis): (Chapter III)

TW N 5: ABIOTIC FACTORS (Edaphic Factors): (Chapter III)

TW N 6: BIOTIC FACTORS: (Chapter IV)

TW N 7: STRUCTURE AND FUNCTIONING OF ECOSYSTEMS: (Chapter V)

TW N 8: ENERGY FLOWS AND THE CONCEPT OF PRODUCTIVITY: (Chapter VI)

TW N 9: MOVEMENT OF MATTER IN ECOSYSTEMS AND MAJOR BIO- GEOCHEMICAL CYCLES: (Chapter VI)

TW N 10: IMPACT OF HUMAN ACTIVITIES ON BIOLOGICAL BALANCES: (Chapter VII)

INTRODUCTION

Understanding ecology is very important to the understanding of Earth's future. It provides the basis for considerable utilization of natural resources facilitating in the conservation of habitats and species, and also for the prediction on reflection of man's activities on natural environment. This clearly explains that ecology is concerned with relationships between living organisms: plants, animals, microorganisms and their environment. Ecologists study the way in which organisms, populations, communities and ecosystem's function and in doing so encompass many other areas of knowledge.

Understanding how our living environment works is essentially a study of ecological systems. Ecology is the science of how organisms interact with each other and with their environment, and how such interactions create self-organizing communities and ecosystems. This science touches us all. The food we eat, the water we drink, the natural resources we use, our physical and mental health, and much of our cultural heritage is to a large degree product of ecological interactions of organisms and their environment.

After completing the Tutorial, students will demonstrate the acquisition of basic knowledge about the ecology research, terminology, basics of theoretical and applied ecology, ecosystem at community level, ecological classification of habitat types, terrestrial and aquatic biomes, with their specific features. They can generalize basic ecological phenomena regardless of the systematic affiliation of organisms in studying their interrelationships with both biotic and abiotic environments, they can comprehend how these relationships affect the distribution of species and their abundance. Students will have knowledge of niche ecology and its role in community formation. They can distinguish the various physical factors in the environment such as soil, water, light and temperature. They can explain in detail various properties of these physical factors, and describe adaptations in plants and animals growing in water and dry habitats.

In these hands-on activities, manipulatives, and charts will help students understand forms of energy, the movement of materials and energy through living communities, and the functional groups of the nutrient cycle compartment?

TW N 1: BASIC CONCEPTS IN ECOLOGY AND FIELDS OF APPLICATION

Tutorial Objectives and intent of the tutorial are that successful students will:

• Understand Key words in Ecology.

• Explain the meaning, scope and basic concepts in ecology and ecosystem.

• Describe the major types of habitats, ecosystems and biomes.

• Know the differences between community, population and organismal scales of ecology.

1. What is Ecology?

The word **Ecology** is derived from the Greek words: " ***oikos*** « meaning house or habitat, and ***logos***, meaning science or study.

Ecology, therefore, is the "science of the house" or "science of habitat". The word 'ecology' was first used by Ernest Haeckel in 1869. He describes *Ecology* as the scientific study of the interactions (relationships) between organisms and their environment.

Ecology is the study of how organisms interact with one another and with their physical environment. This term designates the science study of the conditions of existence of living and the interactions of all kinds between these living and their environment.

2. Fields of Application

Ecological studies traditionally focus on three levels: the individual, the population, and the community.

- **Individual**: A single organism from a particular species.
- **Population**: A group of individuals of the same species living in the same area at the same time.
- **Community (Biocenosis)**: all of the populations of various species that live and interact in the same area.

Each level corresponds to a specific branch of ecology:

- **Autecology or Ecophysiology:**

  Studies the relationships of a single species with its environment, analyzing tolerance limits and the influence of environmental factors on morphology, physiology, and behavior.

- **Population Ecology** or **Demoecology**:

  Examines the qualitative and quantitative characteristics of populations. Population ecologists study the size, density, and structure of populations and how they change over time.

- **Synecology**: Focuses on interactions between species within a community and their relationship with the environment.

3. The Concept of Ecological System: Ecosystem

An ecological system, or ecosystem, is defined as a system formed by two inseparable elements: the **biocenosis** and the **biotope**.

$$\textbf{Ecosystem} = \textbf{Biotope} \otimes \textbf{Biocenosis}$$

The use of the « ⊗ » symbol (tensor product) was proposed by **Frontier & Pichod-Viale (1995)** to replace the traditional "+" symbol. This mathematical notation highlights the interactions between the interconnected elements.

(Explain these terms with the example below and others if necessary)

3.1 Biocenosis

Biocenosis refers to all the organisms that coexist within an ecosystem, including:

- **Zoocenosis** (animal communities)
- **Phytocenosis** (plant communities)
- **Microbiocenosis** (microbial communities)
- **Mycocenosis** (fungal communities)

3.2 Biotope

The biotope (or ecotope) is the portion of the biosphere that provides the abiotic environment essential for biocenosis. It is also defined as the set of abiotic ecological factors (substrate, soil as "edaphotope," climate as "climatotope") that characterize the habitat of a specific biocenosis.

Example of an Ecosystem:

A forest is an example of an ecosystem composed of trees, herbaceous plants, animals, and soil.

- **Ecosystem**: Forest
- **Biocenosis**: Includes both:
    - **Phytocenosis** (vegetation such as trees and herbaceous plants)
    - **Zoocenosis** (animals)
- **Biotope** : Soil

3.3. Multiscalar Nature of Ecosystems

The concept of an ecosystem is **multiscalar** (multi-scale), meaning it can apply to portions of the biosphere of varying dimensions, such as a lake, a meadow, or a decaying tree.

Depending on the scale of the ecosystem, we have:

1. **Micro-ecosystem**: Example - A single tree.
2. **Meso-ecosystem**: Example - A forest.

3. **Macro-ecosystem**: Example - An entire region

5.2. Classification of Ecosystems Based on Biotopes

Ecosystems are often classified by reference to the biotopes concerned. We speak of:

- Continental (or terrestrial) ecosystems such as: forest ecosystems (forests), grassland ecosystems (meadows), agro-ecosystems (agricultural systems).

• Ecosystems of continental waters, for lentic ecosystems of slow-renewing still waters (lakes, marshes, ponds) or lotic ecosystems of flowing waters (rivers, streams).

• Ocean ecosystems (seas, oceans).

4. The Biosphere

The biosphere is the portion of the Earth's crust where life is possible. It includes:

- A part of the **lithosphere** (solid layer of Earth's crust)
- A part of the **atmosphere** (gaseous layer surrounding the Earth)
- A part of the **hydrosphere** (water component of the Earth system)

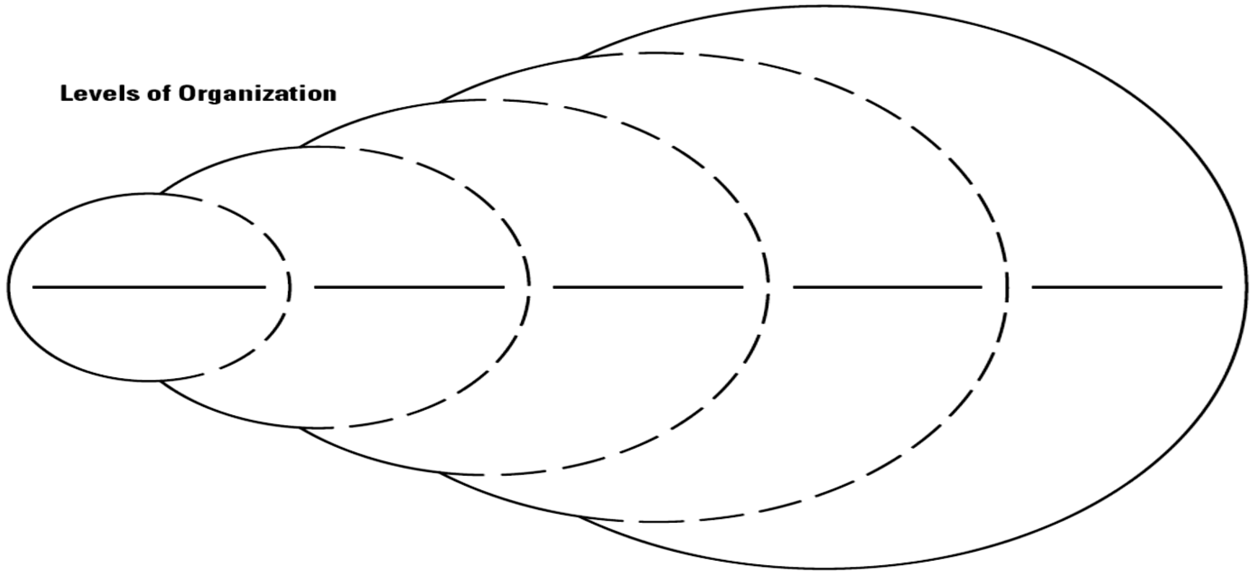
APLICATION:

Question 1: Ecologists study environments at different levels of organization.

Write a description of each level of organization in the table. Also, provide an example for each level.

Level	Description	Example
1. Organism		
2. Population		
3. Community		
4. Ecosystem		
5. Biosphere		

Question 2: Fill in the diagram below with the Levels of Organization studied in Ecology. Use the terms from the table above.



TW N 2: INTERACTION OF ENVIRONMENTS AND BIOCENOSIS:

An environmental factor, ecological factor or eco factor is any factor, abiotic or biotic, that influences living organisms. The abiotic factors are non-living chemical and physical elements that influence an ecosystem.

Question 1: Complete the table below with the following terms:
Eurythermic, Temperature, Stenohydric, Water, Stenoedaphic, Soil, Euryphagic, Food, Euryhydrique, Water, Stenonhaline, Salinity, Eurydaphic, Soil, Stenoionic, pH

Organisms	**Ecological factor**	**Ecological valence (High / Low)**

Question 2: What is a limiting factor?
Question 3: What is the difference between a habitat and an ecological niche?
Question 4: Complete the following sentences with: stenothermal, mesothermal, eurythermal:
- The Snow Flea (*Boreus hyemalis*), is an ……………………….. insect that are only found in the colder period of the year between -12°C and 32°C.
- The Ice Fish (*Trematomus bernacchii*) is a ………………………. species native to the Southern Ocean, with water temperatures between −1 and −1.9°C.
- The Madrepore is a ……………..………. coral of tropical seas that living in various stony corals between 20°C and 27°C.

TW N 2: ABIOTIC FACTORS (Solution):

Question 1: Complete the table below with the following terms:
Eurythermic, Temperature, Stenohydric, Water, Stenoedaphic, Soil, Euryphagic, Food, Euryhydrique, Water, Stenonhaline, Salinity, Eurydaphic, Soil, Stenoionic, pH

Organisms	**Ecological factor**	**Ecological valence (High / Low)**
Eurythermic	Temperature	High
Stenohydric	Water	Low
Stenoedaphic	Soil	Low
Euryphagic	Food	High
Euryhydric	Water	High
Stenohaline	Salinity	Low
Eurydaphic	Sol	High
Stenoionic	pH	Low

Question 2: What is a limiting factor?
A limiting factor is any ecological factor that, when it is absent or reduced below a critical threshold, or when it exceeds the maximum tolerable level, restricts or prevents the establishment and growth of an organism in a given environment. Essentially, the limiting factor dictates the species' distribution and success within its habitat. This can apply to factors such as nutrients, temperature, water, light, and others, depending on the specific needs and tolerance of the organism.

Question 3: What is the difference between a habitat and an ecological niche?

1. Concept of Ecological Niche

Organisms of a given species can sustain viable populations within a specific set of conditions, utilizing particular resources in a defined environment and during precise timeframes. This intersection of factors constitutes the ecological niche, which defines the position or function of an organism or a population within a biological and physical environment including:

- **The conditions of its environment**
- **The utilized resources**
- **The times during which it is active**

Over time, organisms can adapt to or modify their niche as they develop.

2. Concept of Habitat

The **habitat** of an organism refers to the physical environment in which it lives. Unlike the niche, which represents the role and interactions of the organism within this environment, the habitat is purely the organism's living space. A single habitat can contain multiple niches and support diverse species.

Example:

A forest serves as a habitat with numerous niches, supporting various species such as:

- **Birds**: Nuthatches, woodcocks;
- **Mammals**: Wood mice, foxes;
- **Insects**: Butterflies, beetles, aphids;
- **Plants**: Wood anemones, mosses, lichens;

Question 4: Complete the following sentences with: stenothermal, mesothermal, eurythermal:

- The Snow Flea (*Boreus hyemalis*), is an **eurythermal** insect that are only found in the colder period of the year between -12°C and 32°C.

- - The Ice Fish (*Trematomus bernacchii*) is a **stenothermal** species native to the Southern Ocean, with water temperatures between −1 and −1.9°C.
- - The Madrepore is a **mesothermal** coral of tropical seas that living in various stony corals between 20°C and 27°C.

TW N 3: ABIOTIC FACTORS:

A-Climatic factors

1.Definition of Climate

Climate refers to the set of atmospheric and weather conditions specific to a region of the globe. Climate is the long-term pattern of weather in a particular region. We usually define a region's climate over a period of 10 years. The climate of a region is determined by studying meteorological parameters (temperature, humidity levels, precipitation (rainfall), wind speed and direction, duration of sunlight, atmospheric pressure etc.)

2-Climate scale: the climate can be considered at different spatial scales:

. Macro-climate: the overall climate of a large geographic area, such as state or a country.

. Meso-climate: occupy medium-sized habitats (a few square kilometers), this is a climate in a specific site affected by altitude (the height of a place above sea level), latitude (refers to the distance of a location from the equator), ocean proximity, prevailing winds, water, etc

. Microclimate small area whose climate conditions differ from their surroundings. is the distinctive climate of a small-scale area.

3. Main Climatic Factors

3.1 Temperature

Temperature is a physical quantity that quantitatively expresses the attribute of hotness or coldness. It reflects the average kinetic energy of the vibrating and colliding atoms making up an ecosystem.

The most common scales are the Celsius °C scale (formerly called centigrade), the Fahrenheit scale (°F), and the Kelvin scale (K).

On the **Celsius** scale, the freezing point of water is 0 °C and the boiling point is 100 °C. The unit of temperature on this scale is the degree Celsius (°C). The **Fahrenheit** scale has the freezing point of water at 32 °F and the boiling point at 212 °F. Its unit is the degree Fahrenheit (°F). The **Kelvin** scale (K) is the absolute temperature scale that is commonly used in science. The International System of Units (SI) temperature unit is the kelvin K (no degree symbol used.

Temperature scales and conversion

Celsius to Kelvin: K = C + 273.15 Fahrenheit to Celcius: C = (F-32) (5/9)

Kelvin to Celcius: C = K - 273.15 Celsius to Fahrenheit: F = C (9/5) + 32

Fahrenheit to Kelvin: K = (F-32) (5/9) + 273.15 or K = (°F + 459.67) × 5/9

Kelvin to Fahrenheit: F = (K-273.15) (9/5) + 32 or F =9/5 × K – 459.67

Temperature is an extremely important climatic element. It ultimately determines the type of climate for a specific region.

3.2 Humidity

Absolute humidity (AH): Humidity of air can be described as absolute humidity, it refers to the amount of water vapors presents per unit volume of air, in terms of gramme per cubic meter (g/m^3).

Saturated humidity (SH): Air is said to be saturated when the amount of water vapor in the air is the maximum possible at an existing temperature and pressure.

The relative humidity (RH): Relative humidity is the ratio of the actual amount of moisture present, to the amount of moisture the air could hold at the given temperature – expressed as a percentage. RH = (AH / SH) X 100

3.3 Precipitation:

Precipitation is the second most important climatic element. Water is the basis of life for all living beings on the earth. Precipitation is expressed in millimeters. Water constantly moves around the earth and changes between solid (snow, sleet, hail and ice), liquid (rain, water droplets) and gas (water vapor). the annual rainfall (precipitation) is a major factor in determining the distribution of plants and animals.

APLICATION:

Exercice1:

Convert the following temperatures into kelvin: 120C°; 180C°;19C°; 5C°; 225F; 45F; 15F; 2F.

Convert the following temperatures into Celsius: 25K; 120K; 0K;17K; 200F; 145F; 5F; 27F.

Convert the following temperatures into Fahrenheit: 0C°; 120C°;9C°; 75C°; 125K; 68K; 20K.

Exercise 2:

A forest contains trees, shrubs, herbaceous vegetation, many mammals, reptiles, birds... etc. During the winter, we recorded a temperature of 278.15 kelvin, with a water vapor of $6g/m^3$, so the climate is very humid, indeed, saturation at this temperature is $6.8g/m^3$. In summer, the temperature rises to 113°F.

1. What is the type of this climate?

2. Convert these temperatures to degrees Celsius?

3. Calculate relative humidity?

SOLOUTION

Exercice1:

From Celsius to Kelvin:

K = C + 273.15

120C°= 393.15K

180C°= 453.15K

19C°= 292.1K

5C°= 278.15K

From Celsius to Fahrenheit:

F = C (9/5) + 32

0C°= 32°F

120C°= 248°F

9C°= 48.2°F

75C°= 167°F

From Fahrenheit to Kelvin:

K = (°F + 459.67) × 5/9

225°F= 380.37K

45°F= 280.37K

15°F= 263.40K

2°F= 256.48K

From Kelvin to Fahrenheit:

9/5 × K – 459.67

125K= -234.67°F

68K= -1337.27°F

20K= -423.67°F

From Kelvin to Celcius:

C = K - 273.15

25K= - 248.15C°

120K= - 153.15C°

0K= -273.15C°

17K= - 256.15C°

From Fahrenheit to Celcius:

C = (F-32) (5/9)

200°F= 93.33C°

145°F= 62.78C°

5°F= -15 C°

27°F = -2.78C°

Exercice2:

1- This climate is a mesoclimate
2- 278.15 kelvin = 5°C (T(Celsius) = T(Kelvin) – 273.15)
   113°F = 45°C (T(Celsius) = 5/9 (T(Fahrenheit) – 32)
3- The relative humidity (RH):
   RH = (AH / SH) X 100 = 6/6.8 *100 = 88.23%

TW N 4: CLIMATIC FACTORS (Bioclimatic Analysis):

Bioclimate Tools:

Climate is determined by the temperature and precipitation characteristics of a region over time. Those factors are very interesting to better understand its evolution and its influence on the distribution of plant and animal life. The Bioclimatic Analysis Tool is a spreadsheet that calculates, plots and analyzes several parameters and criteria based on equations and diagrams.

1- Ombrothermic diagrams of Bagnouls and Gaussen

Ombrothermic diagram also called as pluviothermic diagram (pluvio = rainfall) is a graphical representation used to identify the duration of the dry period for a region based on a comparison of average monthly of temperatures in °C with those of rainfall in mm. The data must be average for mor than 10 years.

• Bagnouls and Gaussen (1953) consider that a month is **dry** if the total monthly precipitation expressed in millimeters (mm) is equal to or less than **twice** the average temperature (M+m/2) expressed in degrees Celsius(°C), "**P≤2T**". According to the definition of “aridity" proposed by Gaussen (1963), the aridity occurs when the ratio p/t < 2.

On graph paper, draw the x-axis marking each of the months. Draw two y axes one for temperature in degree Celsius (on the right side) and another for rainfall in mm (on the left).

In particular, the precipitation values are reported in double scale compared to those of the temperatures (**P=2T**), the area between the two curves indicates the length and drought period:

• When the temperature line runs above the precipitation line there is a **dry** season.

• When the temperature line runs below the precipitation line there is a **wet** season.

2- Emberger’s pluviothermic climagram

Emberger pluviothermic quotient (Q2), classifies the bioclimate zones in the **Mediterranean** area from the “Per-Humid” to “Per-Arid” bioclimatic stages. Emberger subdivided the climatic zone into characteristic zones combining the rainfall-thermal quotients Q2 obtained and the minimum temperatures of the coldest month (m) (Winter Characterization).

The Emberger quotient (Q2) is calculated using the following formula:

$$\boxed{Q_2 = 2000\, P / M^2 - m^2}$$

P is the annual precipitation,

M is the maximum air temperature of the hottest month (in K),

m is the minimum air temperature of the coldest month (in K).

According to the value of the Q2 quotient and m (ºC), the bioclimate can be characterized as:

Emberger Q2	**Bioclimatic stages**	**m (ºC)**	**Winter Characterization**
Q1 > 170	Per-Humid (PeHu)	m > 10 oC	Very Hot (VHo)
120 < Q1 ≤ 170	Humid (Hu)	7 oC < m ≤ 10 oC	Hot (Ho)
65 < Q1 ≤ 120	Sub-Humid (SuHu)	3 oC < m ≤ 7 oC	Temperate (Te)
30 < Q1 ≤ 65	Semi-Arid (SeAr)	0 oC < m ≤ 3 oC	Cool (Co)
17 < Q1 ≤ 30	Arid (Ar)	-3 oC < m ≤ 0 oC	Cold (Cd)
0 < Q1 ≤ 17	Per-Arid (PeAr)	m ≤ -3 oC	Very Cold (VC)

The simplified Emberger pluviothermic quotient by Stewart (1968) (used for Algeria and Morocco) is calculated as:

Q3 =3.43 P/M - m where: **M** and **m** expressed in degrees Celsius (°C)

Exercise: Basis on the following data collected from a meteorological station,

- Draw ombrothermic diagram and identify the dry and wet season for the following stations.
- Represent on the Emberger's climagram the bioclimatic stages for the tow stations.

Tab. I: Climate data for Setif (1990-2011)

Mois	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
P (mm)	40,3	34.5	32.9	43.8	45,7	20,1	12,8	13,9	46,8	31,6	38,4	43,0
Min (°C)	1,9	2,2	4,7	6,8	11,5	16,3	19,7	19,7	15.5	11,5	6,3	2,8
Max (°C)	9,9	11,4	14,6	17,3	23,2	29,5	33,6	32,6	27	21,4	14,8	10,5
(Max+Min)/2 (°C)	**5,9**	**6,8**	**9,6**	**12,05**	**17,35**	**22,9**	**22,65**	**26,15**	**21,25**	**16,45**	**10,55**	**6,65**

Tab. II: Touggourt region climate data (2001-2012)

Mois	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
P (mm)	17,23	1,34	5,04	7,96	1,44	5,55	0,07	1,19	12,5	6,63	1,42	6,07
Min (°C)	4,79	5,85	10,46	14,51	19,24	24,09	28,19	26,6	22,58	17,37	9,81	6,9
Max (°C)	17,41	19,48	24,4	28,68	33,58	38,81	42,49	41,17	35,67	30,37	23,12	18,01
(Max+Min)/2 (°C)	**10,79**	**12,69**	**17,23**	**21,31**	**26,38**	**31,68**	**34,33**	**33,92**	**29,04**	**23,62**	**16,13**	**11,35**

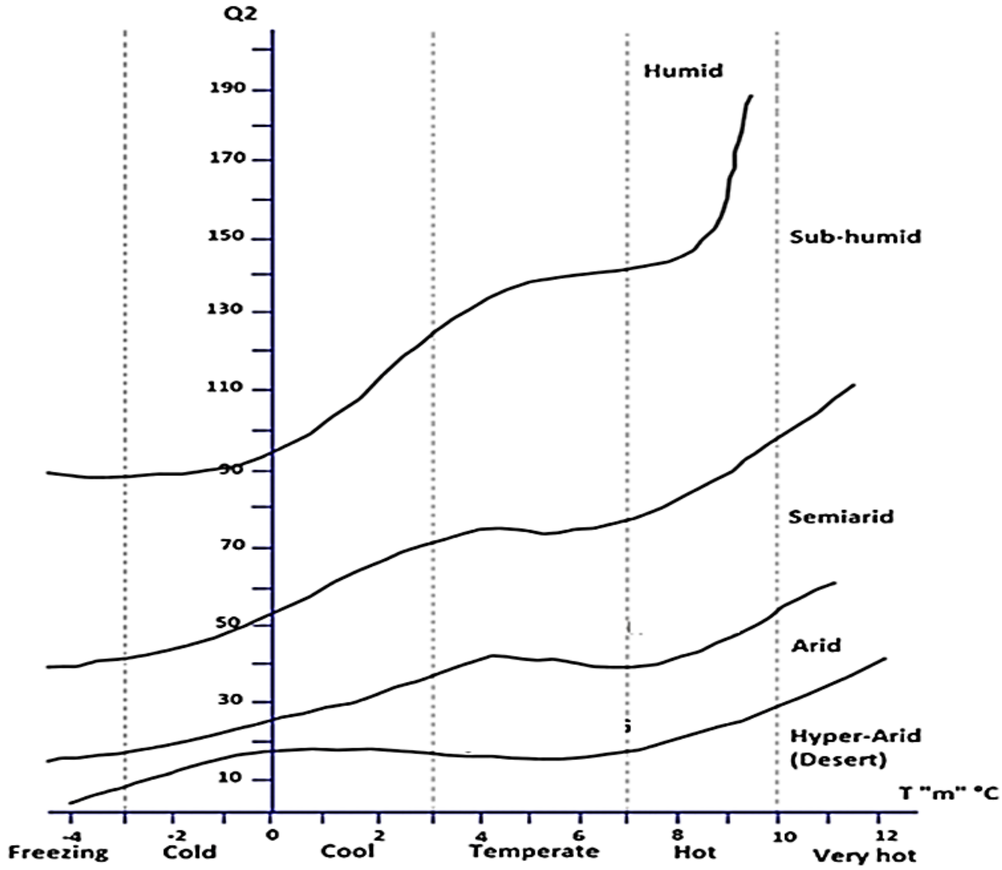


Fig. 1. Emberger's climagram displaying the various types of Mediterranean bioclimates

TW N 4: BIOCLIMATIC ANALYSIS (Solution):

Exercise:

Tab. I: Climate data for Setif (1990-2011)

Mois	J	F	M	A	M	J	J	A	S	O	N	D
P (mm)	40,3	34.5	32.9	43.8	45,7	20,1	12,8	13,9	46,8	31,6	38,4	43,0
Min (°C)	1,9	2,2	4,7	6,8	11,5	16,3	19,7	19,7	15.5	11,5	6,3	2,8
Max (°C)	9,9	11,4	14,6	17,3	23,2	29,5	33,6	32,6	27	21,4	14,8	10,5
(Max+Min)/2 (°C)	**5,9**	**6,8**	**9, 6**	**12,05**	**17,35**	**22,9**	**22,65**	**26,15**	**21,25**	**16,45**	**10,55**	**6,65**

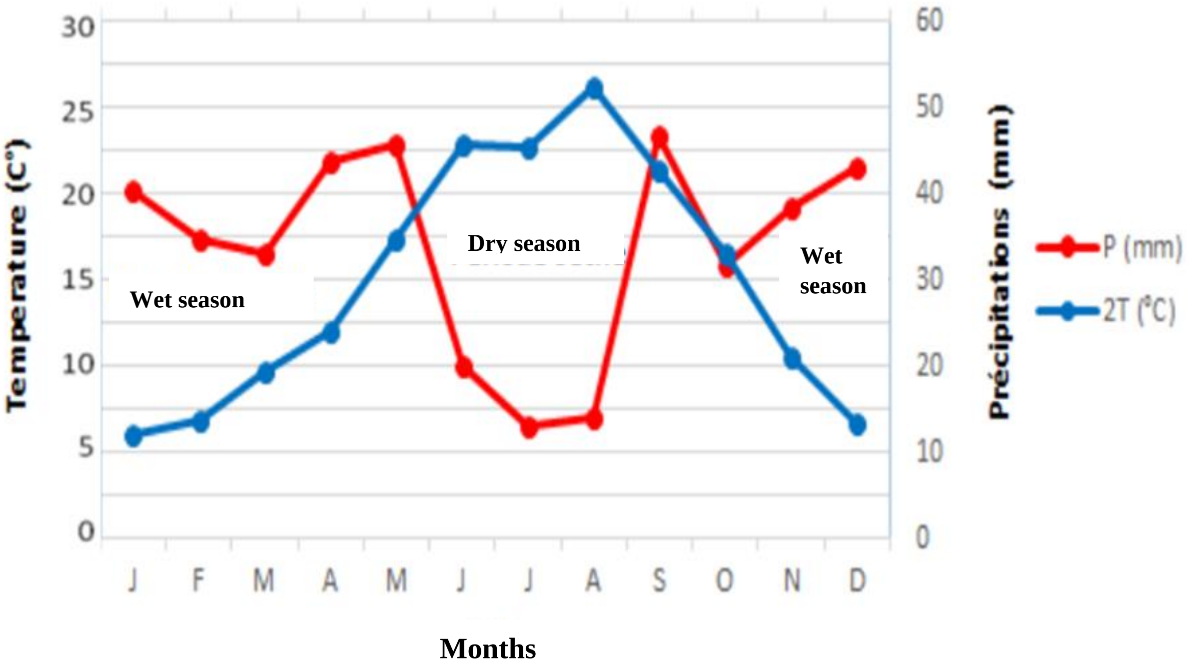


Fig. 1. Ombrothermic diagram of Setif (1990-2011)

Setif: The dry season (precipitation lower than 2 times the air temperature) corresponds to the warmest period of the year and extends over five/ six months (Fig. 1); from May/June to October, with 403.8 mm/year of the total average rainfall. and a maximum temperature of 33.6°C recorded in July.

The wet period, which extends over the rest of the months of the year, with a minimum temperature of 1.9°C in January.

Tab. II: Touggourt region climate data (2001-2012)

Mois	J	F	M	A	M	J	J	A	S	O	N	D
P (mm)	17,23	1,34	5,04	7,96	1,44	5,55	0,07	1,19	12,5	6,63	1,42	6,07
Min (°C)	4,79	5,85	10,46	14,51	19,24	24,09	28,19	26,6	22,58	17,37	9,81	6,9
Max (°C)	17,41	19,48	24,4	28,68	33,58	38,81	42,49	41,17	35,67	30,37	23,12	18,01
(Max+Min)/2 (°C)	**10,79**	**12,69**	**17,23**	**21,31**	**26,38**	**31,68**	**34,33**	**33,92**	**29,04**	**23,62**	**16,13**	**11,35**

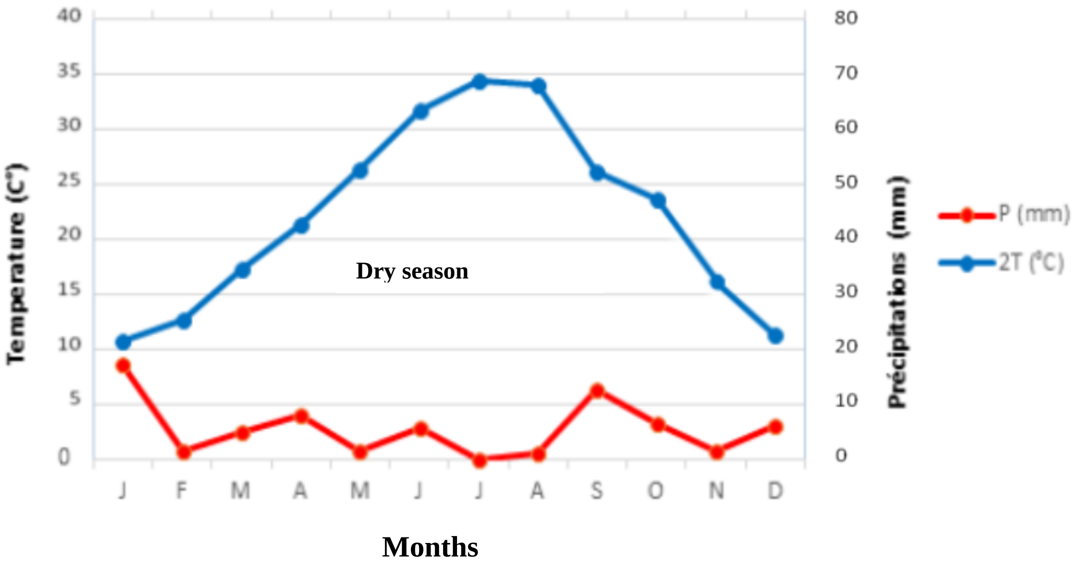


Fig. 2. Ombrothermic diagram of Touggourt (1990-2011)

The ombrothermic diagram showed, that Touggourt characterized by a long dry season lasting for all year (12 months), with maximum temperatures higher than 42 °C recorded in July and the minima values m=4.79°C, registered in January. The annual rainfall is very low, not exceeding 67 mm / year.

1- **Emberger's pluviothermic climagram**

The Emberger quotient (Q2) is calculated using the following formula:

$$\boxed{Q_2 = 2000\ P / M^2 - m^2}$$

P is the annual precipitation,

M is the maximum air temperature of the hottest month (in K),

m is the minimum air temperature of the coldest month (in K).

The simplified Emberger's pluviothermic quotient by Stewart (1968) (used for Algeria and Morocco) is calculated as:

Q3 =3.43 P/M - m where: **M** and **m** expressed in degrees Celsius (°C)

Tab. III : Precipitations, Tempratures (M et m) and Q2 calculed :

Region	M (°C)	M (Kelvin)	m (°C)	m (Kelvin)	P (mm)	Q2	Periode
Setif	33.6	306.75	1.9	275.07	403.8	**43.81**	1990-2011
Tougourt	42.49	315.64	4.79	277.94	66.44	**5.95**	2001-2012

Based on Emberger's pluviothermal quotient Q2= **43.81**, and the minimum temperatures of the coldest month (m=1,9°C), **Setif** classified under semi-arid bio-climate with Cool and fresh winter.

Touggourt presente a Q2 =5.95 and m=4.79°C. According to the Emberger's pluviothermic climagram, the climate of Touggourt is classified as a desertic or Saharian bioclimate (Hyper-Arid) with Temperate winter.

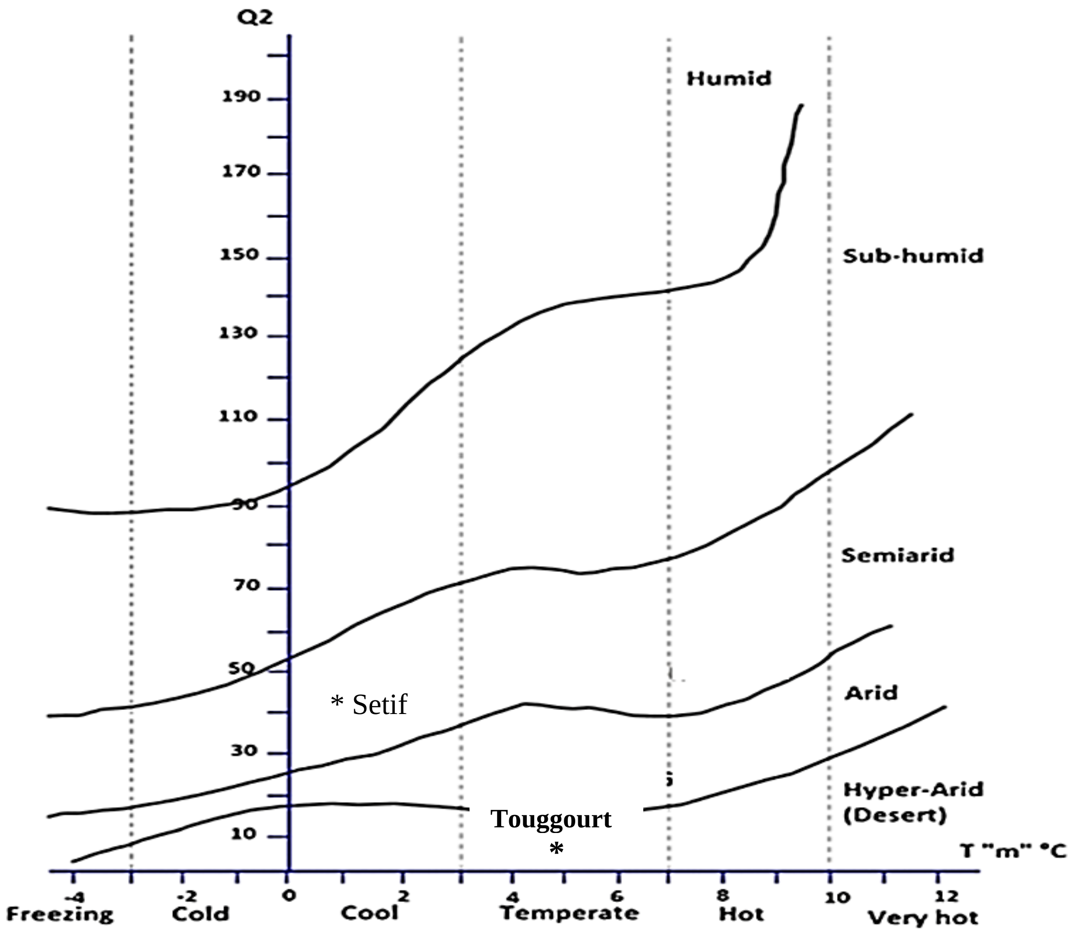


Fig. 3. Emberger's climagram displaying the various types of Mediterranean bioclimates

TW N 5: ABIOTIC FACTORS (Edaphic Factors):

B- Edaphic Factors

The edaphic factors are the soil properties that affect the diversity of organisms living in the soil environment. These include soil structure, temperature, pH, Soil moisture (water content of the soil) and mineral salt content (salinity).

Edaphic factors – These include soil, its structure and properties. Parameters such as soil type, soil profile, organic matter, minerals, soil and soil organisms are included in it.

1. What is Soil?

Soil is a natural resource formed by weathering (breakdown) of parent rocks. Soil acts as a substrate that provides mechanical support to plants and as a reservoir of water and nutrients for plants life and microscopic communities. It has been defined as the matrix (sand-silt-clay) containing living biomass and dead organic matter with some concentration of air and water.

Soil is classified based on various factors such as texture, structure, color, pH level, and organic content.

2. Soil texture

A physical property of mineral soils defined by the size (diameter) of soil particles. Soil texture varies according to the percentage of sand, silt and clay. Sand is composed of large particles, silt is medium particles, and clay is small particles: sand (2 mm-0.05 mm), silt (0.05 -0.002 mm), clay (<0.002 mm).

3. Soil texture triangle: A soil texture triangle is a graphical tool used to determine soil texture based on the proportions of sand, silt, and clay particles in a soil sample (Fig. 1). This triangle is used so terms like “clay” or “loam” always have the same meaning. Each texture corresponds to specific percentages of sand, silt, or clay.

APLICATION:

Exercice: Define the textures of the 05 samples using the soil texture triangle

N°	% clay	% silt	% sand	Soil texture
1	30	40	30	
2	20	60	20	
3	70	20	10	
4	5	85	15	
5	15	20	65	

Using the Triangle

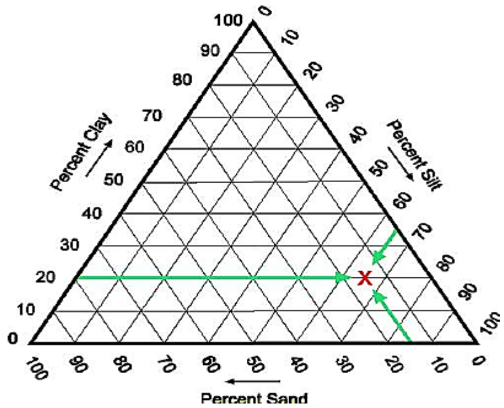
The triangle is equilateral, each side of the triangle has a scale of 0 to 100 percent. The triangle used here has Clay on the left, Silt on the right and Sand at the bottom.

To classify a soil sample, it necessary to put on the three axes the percentages of clay, silt and sand, for each of the points thus found, we trace a parallel to the previous axis (in the order of the arrows). the intersection of the three lines on the triangle give the texture class.

clay extend line horizontal from the % clay i.e., parallel with sand axis

silt extend line downward from % silt i.e., parallel with clay axis

sand extend line upward from % sand. i.e., parallel with silt axis



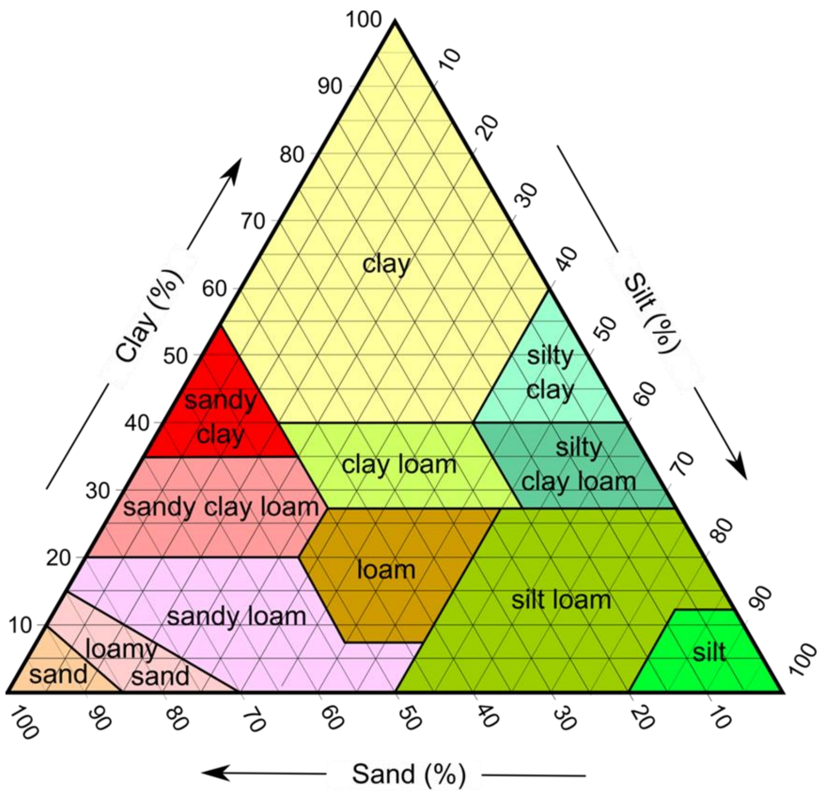


Fig. 1: Soil texture triangle

SOLUTION

Soil texture types

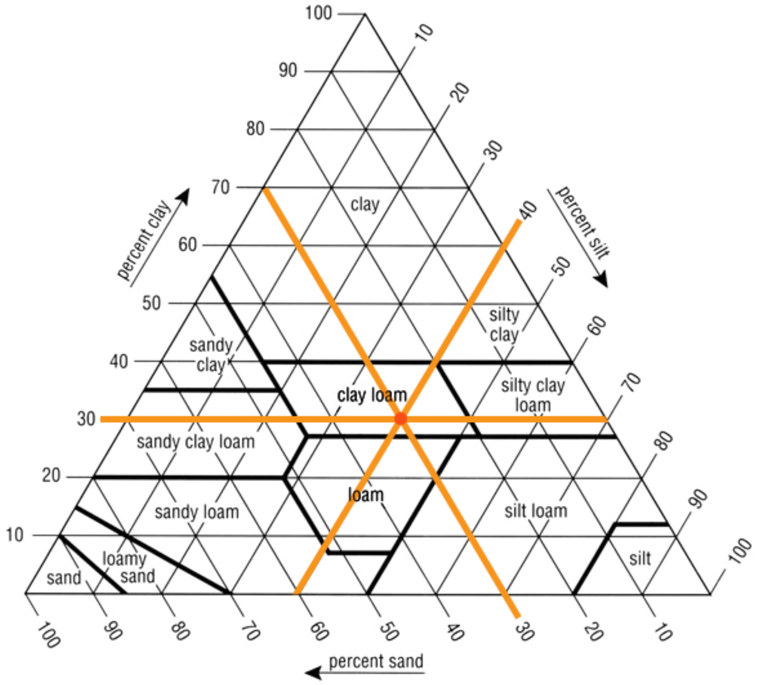
Soils that are 85+% sand with small percentages of silt and clay are called “sand”. Such soils are often called “light” soils. Soils that are 40+% clay are called “clay” and are often called “heavy” soils. When soils contain roughly the same percentage of sand, silt, and clay, they are called “loam” soils.

The 12 basic soil textural classes can be further categorized as coarse soils, medium soils, and fine soils. Sandy soils like sand and loamy sand are categorized as coarse. Clay soils like clay, sandy clay, and silty clay are categorized as fine. All loamy soil textures (sandy loam, loam, silt loam, silt, clay loam, sandy clay loam, and silty clay loam) are categorized as medium.

Example: Classify a soil sample that is 30% clay, 40% silt, and 30% sand.

First locate 30% on the clay axis, and draw a line horizontally from left to right (parallel with sand axis). Next, locate 40% on the silt axis, and draw a line going down diagonally to the left (parallel with clay axis). Finally, locate 30% on the sand axis, and draw a line going up diagonally to the left (parallel with silt axis). The intersection is in a region called **Clay Loam**.

Loam: Soil comprised of almost equal amounts of sand and silt and a little less clay.



The percentages of clay, silt, and sand in the basic textural classes

Exercice: Define the textures of the 05 samples using the soil texture triangle

N°	% clay	% silt	% sand	Soil texture
1	30	40	30	- Clay Loam
2	20	60	20	- Silt loam
3	70	20	10	- Clay
4	5	85	15	- Silt
5	15	20	65	- Sandy loam

TW N 6: BIOTIC FACTORS:

Students discuss the effect of ecological relationships on the processes of population dynamics. Then they Identify the various organismal interactions and classify the ecological relationships as Beneficial or Harmful relationships, and comprehend how biotic elements of an ecosystem interact and depend on one another.

Exercice 1: Place the following biotic relationships in the corresponding category in the table: Group effect – Parasitism – Amensalism – Interspecific competition – Cooperation – Mass effect – Commensalism – Symbiosis.

Beneficial homotypic relationships	Harmful homotypic relationships	Beneficial heterotypic relationships	Harmful heterotypic relationships
……………………… ……………………… ………………………	……………………… ……………………… ………………………	……………………… ……………………… ………………………	……………………… ……………………… ………………………

Exercice 2: Different interactions between organisms are shown in the table below. If we consider two species labeled A and B. Identify whether they benefit, are harmed, or are neutral in the relationship using symbols:

0 : No impact.
+ : Benefits.
- : Harmed.

	Species together		Separate species	
Interaction	**Species A**	**Species B**	**Species A**	**Species B**
Neutralism				
Cooperation				
Symbiose				
Commensalism (A: the commensal, B: the host)				
Amensalism (A: amensal, B: inhibit)				
Competition				
Predation (A: Predator, B: the prey)				
Parasitism (A: Parasite, B: the host)				

SOLUTION:

Exercice 1: Place the following biotic relationships in the corresponding category in the table:

Beneficial homotypic relationships	Harmful homotypic relationships	Beneficial heterotypic relationships	Harmful heterotypic relationships
Group effect	Mass effect	Cooperation Symbiosis	Parasitism Amensalism Interspecific competition Commensalism

Exercice 2: Different interactions between organisms are shown in the table below. If we consider two species labeled A and B. Identify whether they benefit, are harmed, or are neutral in the relationship using symbols:
0 : No impact.
+ : Benefits.
- : Harmed.

	Species together		Separate species	
Interaction	**Species A**	**Species B**	**Species A**	**Species B**
Neutralism	0	0	0	0
Cooperation	+	+	0	0
Symbiose	+	+	-	-
Commensalism (A: the commensal, B: the host)	+	0	-	0
Amensalism (A: amensal, B: inhibit)	0	-	0	0
Competition	-	-	0	0
Predation (A: Predator, B: the prey)	+	-	-	0
Parasitism (A: Parasite, B: the host)	+	-	-	0

ENVIRONMENTAL FACTORS (BIOTIC FACTORS).

B- BIOTIC FACTORS

Biotic factors are all the actions that living organisms exert directly on one another. These are the interactions that occur between the various organisms inhabiting a given environment. These interactions are called coactions. We also distinguish between action that is the influence that the biotope exerts on the biocenosis, the reaction being the opposite effect. These interactions are of two types:

- Homotypic or intraspecific, when they occur between individuals of the same species.

- Heterotypic or interspecific, when they occur between individuals of different species. Homotypic or intraspecific reactions occur between individuals of the same species; co-reactions between individuals of different species are called heterotopic or interspecific reactions.

1. Homotypic coactions

1.1 The group effect

A group effect occurs when animals of the same species change when they are grouped in pairs or larger. The group effect is well known in many insects and vertebrate species, which can only reproduce normally and survive when represented by sufficiently large populations. The group effect is any phenomenon within a population that is directly related to the number of individuals in it. It's the interaction linked to the coming together of individuals and falls within the scope of cooperation. This is a positive effect. It often results in communities characterized by alliances (migratory communities, hunting communities (lions), breeding communities (seabirds). Community size offers protection from enemies, avoids excessive heat loss and increases hunting and breeding success.

Example: It is estimated that a herd of African elephants needs to contain at least 25 individuals to be able to survive: the fight against enemies and the search for food are facilitated by living together.

1.2 The mass effect

In contrast to the group effect, the mass effect occurs when the environment, often overpopulated, provokes severe competition with harmful consequences for individuals. The adverse effects of such competition have consequences for the metabolism and physiology of individuals, resulting in disturbances such as lower fertility rates, reduced birth rates and increased mortality. In some organisms, overcrowding leads to phenomena known as self-elimination.

1.3 Intraspecific competition

This type of competition can occur at very low population densities, and manifests itself in a wide variety of ways:

- Appears in territorial behavior, i.e. when the animal defends a certain area against incursions by other individuals.
- The maintenance of a social hierarchy with dominant and dominated individuals.
- Food competition between individuals of the same species is intense when population density becomes high. Its most frequent consequence is a drop in population growth rates.

In plants, intraspecific competition linked to high densities is mainly for water and light. The result is a reduction in the number of seeds formed and/or high mortality, which greatly reduces the number of plants.

2. Heterotypic cohabitation

The cohabitation of two species can have a neutral, favorable or unfavorable influence on each of them. The various types of interaction encountered in nature are as follows:

2.1 Neutralism

Neutralism occurs when the two species are independent: they coexist without having any influence on each other.

2.2 Cooperation

The two species form an association which is not essential, as each can live in isolation, and which brings benefits to both. For example, trees in a forest can maintain and regenerate in climatic conditions unfavorable to the survival of the same trees in isolation.

2.3 Symbiosis

Each species can only grow, reproduce and survive in the presence of the other. It's an interaction in which both partners find an advantage where species derive a mutual benefit, which can be protection against enemies, dispersal, pollination, the supply of nutrients, etc.

Example: Tree seeds must be dispersed far and wide to survive and germinate. This dispersal is the work of birds, monkeys... who benefit from the tree (food, shelter...).

The obligatory and indispensable association between two species is a form of mutualism, known as symbiosis. In this association, each species can only survive, grow and develop in the presence of the other.

Example: Lichens are formed by the association of an alga and a fungus.

2.4 Commensalism

Interaction between a commensal species, which benefits from the association, and a host species, which neither benefits nor harms. The two species interact in a mutually tolerant manner.

Example: Animals that settle in and are tolerated in the homes of other species.

2.5 Amensalism

This is an interaction in which one species is eliminated by another species that secretes a chemical toxic substance while the other remains unaffected. In plant interactions, amensalism is often referred to as allelopathy.

In most of the amensalism interactions in nature, the species causing the harm usually produce chemicals or other products that negatively impact the other species involved. The production of such products doesn’t occur as a response to the interaction but as the normal working of the species

Example:

- A classic example of amensalism can be observed between the fungal species Penicillium and different bacterial species.
- The fungal species secretes penicillin as a secondary metabolite during growth, but the bacteria sharing a common niche with the mold get negatively affected.
- Black walnut (Juglans nigra) produces a substance called juglone that has an antagonistic effect on various herbaceous plants present in the root zone of the plant, which explains why the vegetation beneath it is so poor.

2.6 Interspecific competition

Interspecific competition can be defined as the active search by members of two or more species for the same environmental resource (food, shelter, egg-laying site, etc.).

In interspecific competition, each species has an adverse effect on the other. The closer two species are to each other, the greater the competition.

However, two species with exactly the same needs cannot cohabit, as one of them is bound to be eliminated after a certain time. This is the Gause principle, or the principle of competitive exclusion.

2.7 Predation

A predator is any free-living organism that feeds at the expense of another. It kills its prey in order to eat it. Predators can be polyphagous (preying on a large number of species), oligophagous (feeding on a few species), or monophagous (subsisting on a single species).

2.8 Parasitism

A parasite is an organism that does not lead a free life: at at least one stage in its development, it is attached to the surface (ectoparasite) or inside (endoparasite) of its host.

Parasitism can be considered a special case of predation. However, the parasite is not really a predator, as its aim is not to kill the host. The parasite must adapt to meet the host and survive at the host's expense. The host must adapt to avoid encountering the parasite, and get rid of it if it does. Like predators, parasites can be polyphagous, oligophagous or monophagous.

TW N 7: STRUCTURE AND FUNCTIONING OF ECOSYSTEMS:

TUTORIAL OBJECTIVES:

• Understand the concept of food chain and food web.

• Define the terms autotrophy and heterotrophy,

• Recognize that food relationship exists among living things,

• Recognize that chemical energy (in the form of carbohydrates, fats, proteins) and nutrients are transferred among producers, consumers and decomposers,

• State that trophic level refers to the parts of food chain,

• Correctly define (or describe) food chains and pyramid of energy/number,

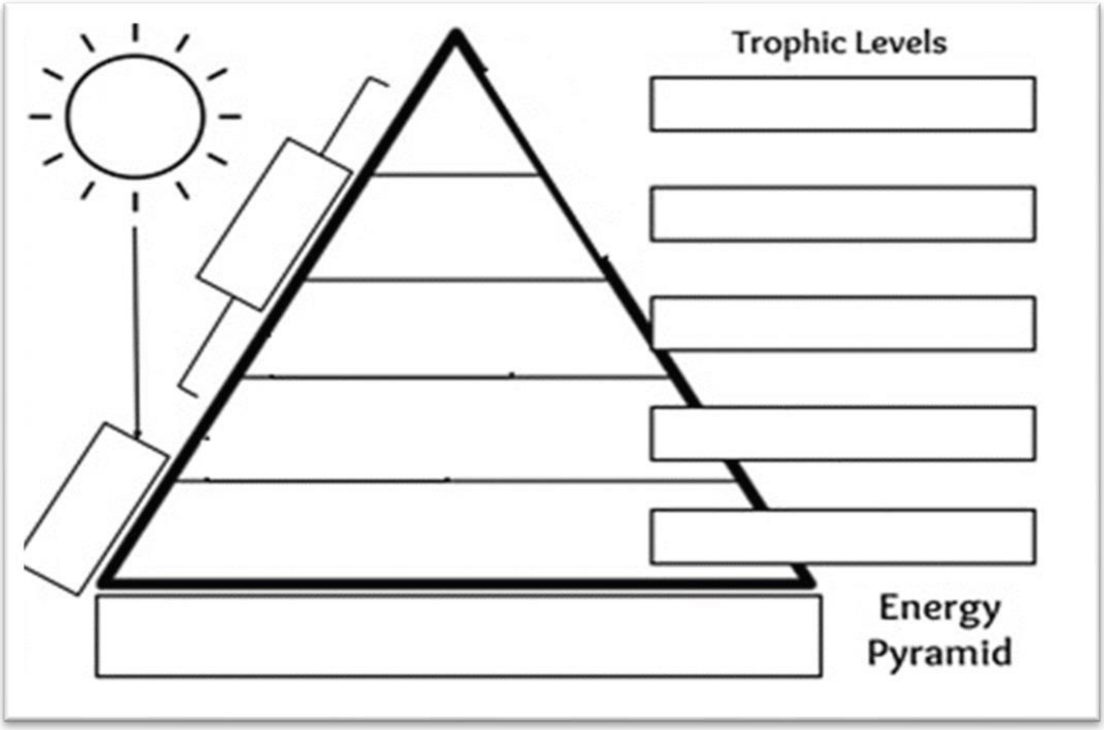
• Describe the nature of energy transfer or flow in the ecosystem,

Exercice 1:

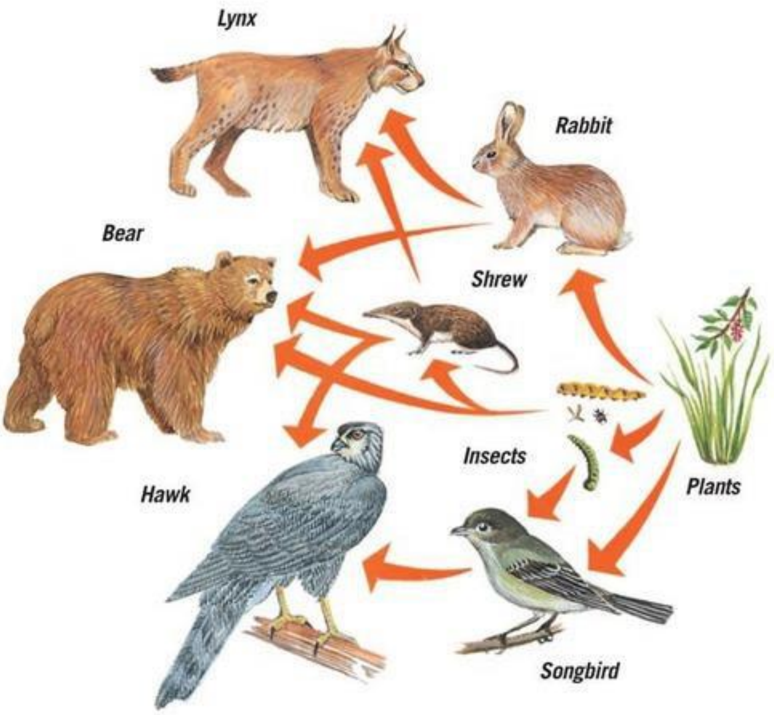
1. The sequence of transfers of matter and energy in the form of food from organism to organism is________________________
2. The position occupied by an organism in a food chain called ________________________
3. The 1st trophic level consists of _________________producers called _____________________.
4. Name the 2nd trophic level (both names). ____________________________________
5. Secondary consumers may be _____________________eating meat or________________that eat both plants and animals.
6. What is the 3rd trophic level called? _______________________
7. What is the 4th trophic level called? _______________________
8. At the 5th trophic level would be ________________consumers that eat___________consumers.
9. What organism feeds on dead plants and animals and helps recycle them? __________________
10. Both _____________________and ___________________act as decomposers.

Exercice 2:

Label the energy pyramid based on the information given in Exercice 1.



Exercice 3: The diagram shows a food web



1. What is the source of energy for this food web?

....

2. What do the arrows indicate?

....

....

3. Name animals which are the prey of the bear. ....
4. How many food chains involve the Shrew? ....
5. How many animals does the Lynx feed on? ....
6. Which organism is an herbivore (secondary consumer)? ....
7. Which organism is a producer? ....
8. Which organism is an omnivore? ....
9. Which organism belongs to more than one trophic level? ....
10. What are decomposers?
11. From the food web draw a food chain containing 4 organisms.

Exercice 4: 1. Reconstruct the food chain studied in the following Data.

2. Define the Ecological Pyramids

3. Choose your own scale and construct the Ecological Pyramids

Trophic levels	**Number**	**Biomass per 1hectare of field**	**Energy (Kj)**
Solar energy	**-**	**-**	**26.334×10^{9}**
Grass	**2.10^{7}**	**8211Kg**	**6.23×10^{7}**
Zebras	**9**	**1635Kg**	**4.97×10^{6}**
Lions	**2**	**48Kg**	**36.7×10^{3}**

Solution:

Exercice 1:

1. The sequence of transfers of matter and energy in the form of food from organism to organism is **food chain**

2. The position occupied by an organism in a food chain called: **trophic level**

3. The 1st trophic level consists of **primary** "producers called **autotrophs** ".

4. Name the 2nd trophic level (both names). **primary consumers, herbivores**

5. Secondary consumers may be **carnivores** eating meat or **omnivores** that eat both plants and animals.

6. What is the 3rd trophic level called? **secondary consumers**

7. What is the 4th trophic level called? **tertiary consumers**

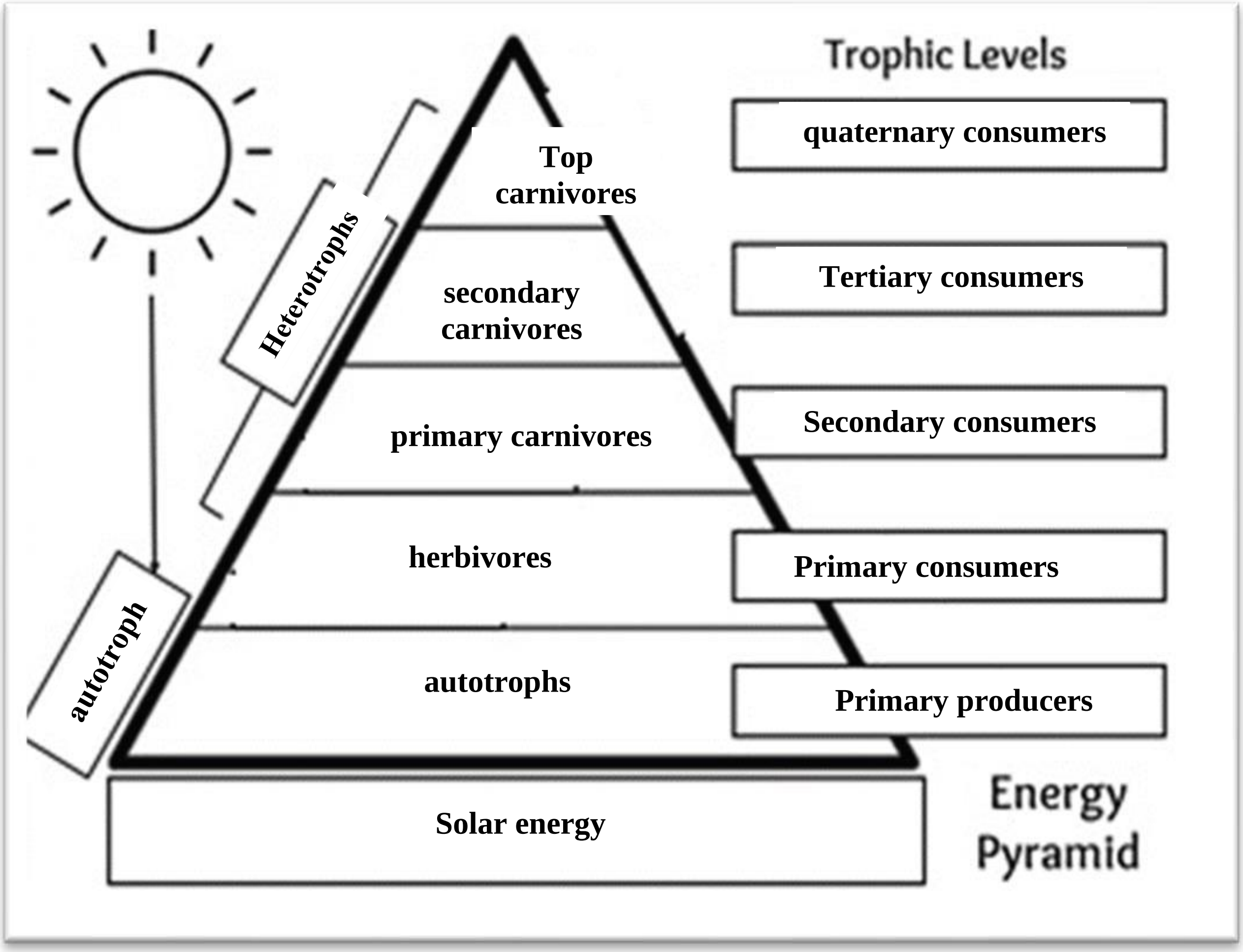
8. At the 5th trophic level would be **quaternary** "consumers that eat **tertiary** consumers.

9. What organism feeds on dead plants and animals and helps recycle them? **decomposers**

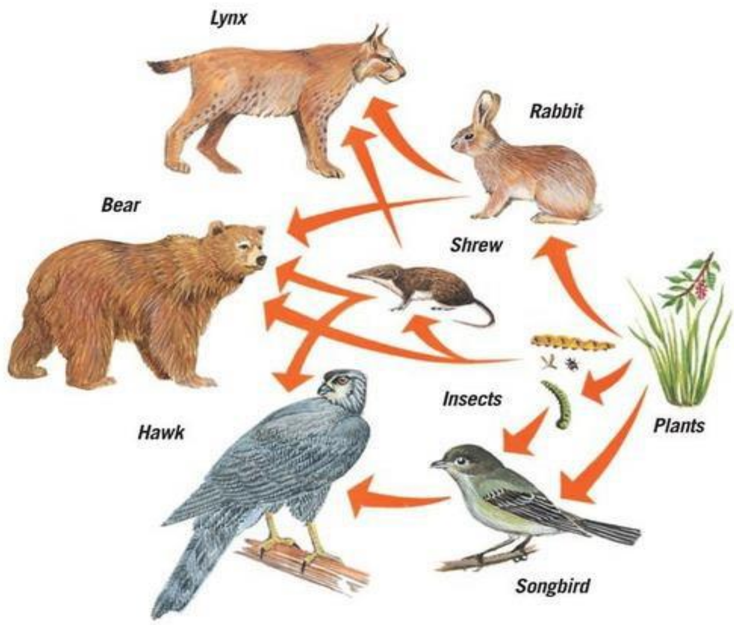
10. Both bacteria and **fungi** act as **decomposers**.

Exercice 2:

Label the energy pyramid based on the information given in Exercice 1.



Exercice 3: The diagram shows a food web



1. What is the source of energy for this food web? **solar energy**

2. What do the arrows indicate? **arrows are used to indicate the flow of energy and transfer of matter in a food chain or web**

3. Name animals which are the prey of the bear. **Rabbit, Shrew and Insects**.

4. How many food chains involve the Shrew? **4 chains**:

(1) Plants → Insects → Shrew.

(2) Plants → Insects → Shrew → Lynx.

(3) Plants → Insects → Shrew → Bear.

(4) Plants → Insects → Shrew → Hawk.

5. How many animals does the Lynx feed on? **2: Rabbit and Shrew**.

6. Which organism is an herbivore (secondary consumer)? **Rabbit, Insects and Songbird**

7. Which organism is a producer? **Plants**

8. Which organism is an omnivore? **Songbird**

9. Which organism belongs to more than one trophic level? **Songbird (herbivores and carnivores)**

10. What are decomposers?

Any of various organisms (such as many bacteria and fungi) that breaks down dead organic material, and recycle those materials back into the Ecosystem.

11. From the food web draw a food chain containing 4 organisms.

Exercice 4:

1. Reconstruct the food chain studied in the following Data.

Solar → energy → Grass → Zebras → Lions

2. Define the Ecological Pyramids:

KEY CONCEPTS:

A food chain is a linear sequence of organisms where each organism eats the one below it and is eaten by the one above it.

Food Web A network of complex interactions formed by the feeding relationship among the various organisms in an ecosystem

“The interconnecting of many food chains is called food web”.

The arrows in a food chain show transfer of matter and the flow of energy, from the sun or hydrothermal vent to a top predator. As the energy flows from organism to organism, energy is lost at each step.

The trophic level in an ecosystem may be defined as a position occupied by an organism in a food chain. The trophic level of an organism is the number of steps it is from the start of the chain

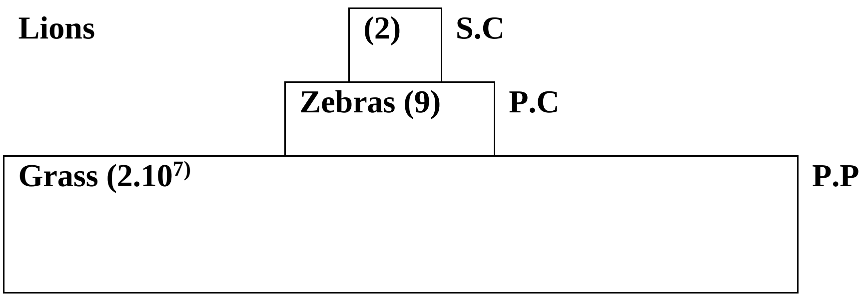
Ecological Pyramids

Ecological Pyramids can be defined as a graphical representation of different ecological parameters, namely the number of individuals found at each trophic level, the energy quantity or the biomass found in each trophic level. These pyramids depict the producers at the base whereas the apex depicts the top-level consumers found in the ecosystem.

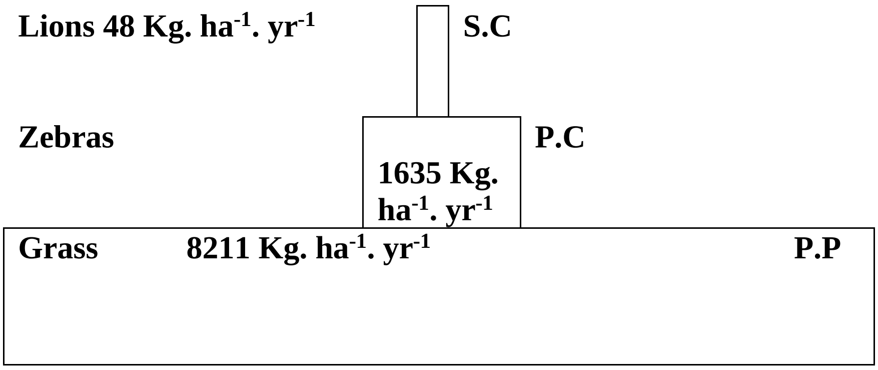
Construction of ecological pyramids: an Ecological Pyramid correspond to the superimposition of horizontal rectangles of equal height, but of lengths proportional to the number of individuals, biomass or quantity of energy present in each trophic level. These are referred to as number, biomass or energy pyramids

3. Choose your own scale and construct the Ecological Pyramids

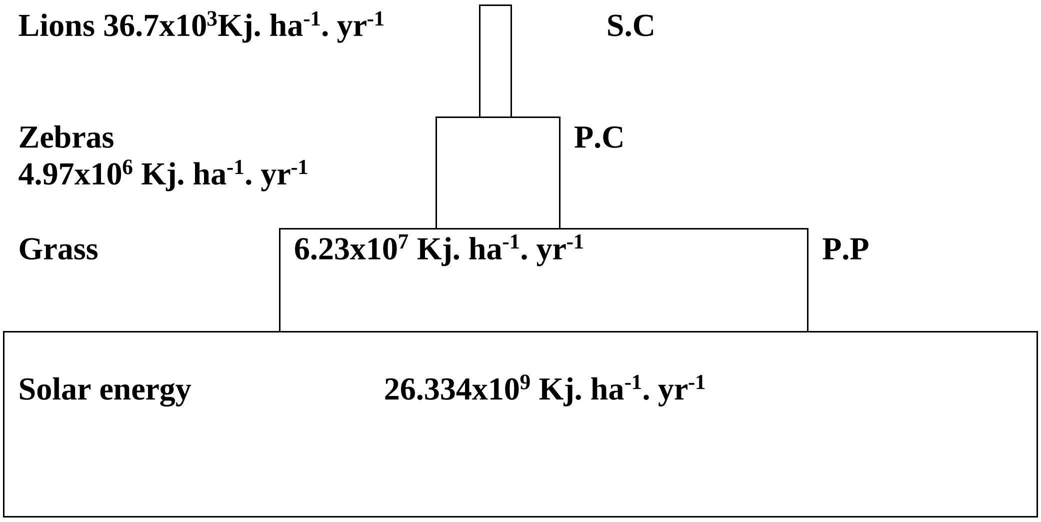
Trophic levels	**Number**	**Biomass per 1hectare of field**	**Energy (Kj)**
Solar energy	**-**	**-**	**$26.334x10^9$**
Grass	**2.10^7**	**8211Kg**	**$6.23x10^7$**
Zebras	**9**	**1635Kg**	**$4.97x10^6$**
Lions	**2**	**48Kg**	**$36.7x10^3$**



Pyramid of Number



Pyramid of Biomass



Pyramid of Energy

TW N 8: ENERGY FLOWS AND THE CONCEPT OF PRODUCTIVITY:

Objectives

After studying this tutorial, students should be able to:

- Explain community/ecosystem energy dynamics, including energy transfer between the difference trophic levels.
- Calculate biomass, net primary productivity (NPP), secondary productivity, and respiration.
- List various forms of energy in nature and outline their uses for life processes of organisms.
- Explain the process of energy flow through ecosystems.
- Describe various types of productivity and their relationships;
- Define ecological efficiency and explain its importance for ecosystems.

Concept of production

Solar energy enters the biotic components of the ecosystem through primary producers. The plants store solar energy in the form of chemical bond energy through the process of photosynthesis. It is usually expressed as the energy or the biomass accumulation over a period of time and designated as kilocalories per square meter (kcal/m^2). It is also expressed as dry organic matter in grams per square meter (g/m2).

Biomass is the total mass, in a unit area at the time of living or previously living organisms within a trophic level. The rate of production over time is called **productivity.**

Technically it is defined as the amount of biomass or organic matter produced per unit area in a given period (It can be expressed in terms of kcal m^2/year or g/m^2/yr. This describes the productivity of trophic level in an ecosystem.

Gross primary production

The rate at which photosynthetic primary producers incorporate energy from the sun is called **gross primary productivity**: It refers to the total amount of solar energy fixed into organic matter by primary producers through photosynthesis.

Net Primary Productivity (NPP)

A considerable portion of the solar energy fixed by plants (GPP) is utilized by plants in respiration (R) to get the energy needed for their metabolism and other vital functions. (NPP) is available to be transferred to the next trophic level.

NPP = GPP – R or GPP = NPP + R

Where: GPP = gross primary productivity

R = respiratory losses

Primary productivity: Net productivity of producers.

Secondary productivity: Net productivity of herbivores, carnivores and decomposes.

Ecological Efficiency: The measurement of energy transfer efficiency between two successive trophic levels is termed the Ecological Efficiency and is defined by the formula:

EE= (production at present trophic level / production at previous trophic level) × 100= $(P_n/P_{n-1}) \times 100$

The efficiency of photosynthesis can be measured as the percentage of energy from sunlight that is converted to gross primary productivity (GPP).

Assimilation Efficiency is the ratio of assimilated energy (A) to ingested energy (I): = $(A/I) \times 100$

Exploitation efficiency (Ingestion) which indicates the quantity of food or energy taken by trophic level. The exploitation efficiency is the ratio of ingested energy (Intake) (I) to available energy, which is the net production of the prey: $(I_n/P_{n-1}) \times 100$

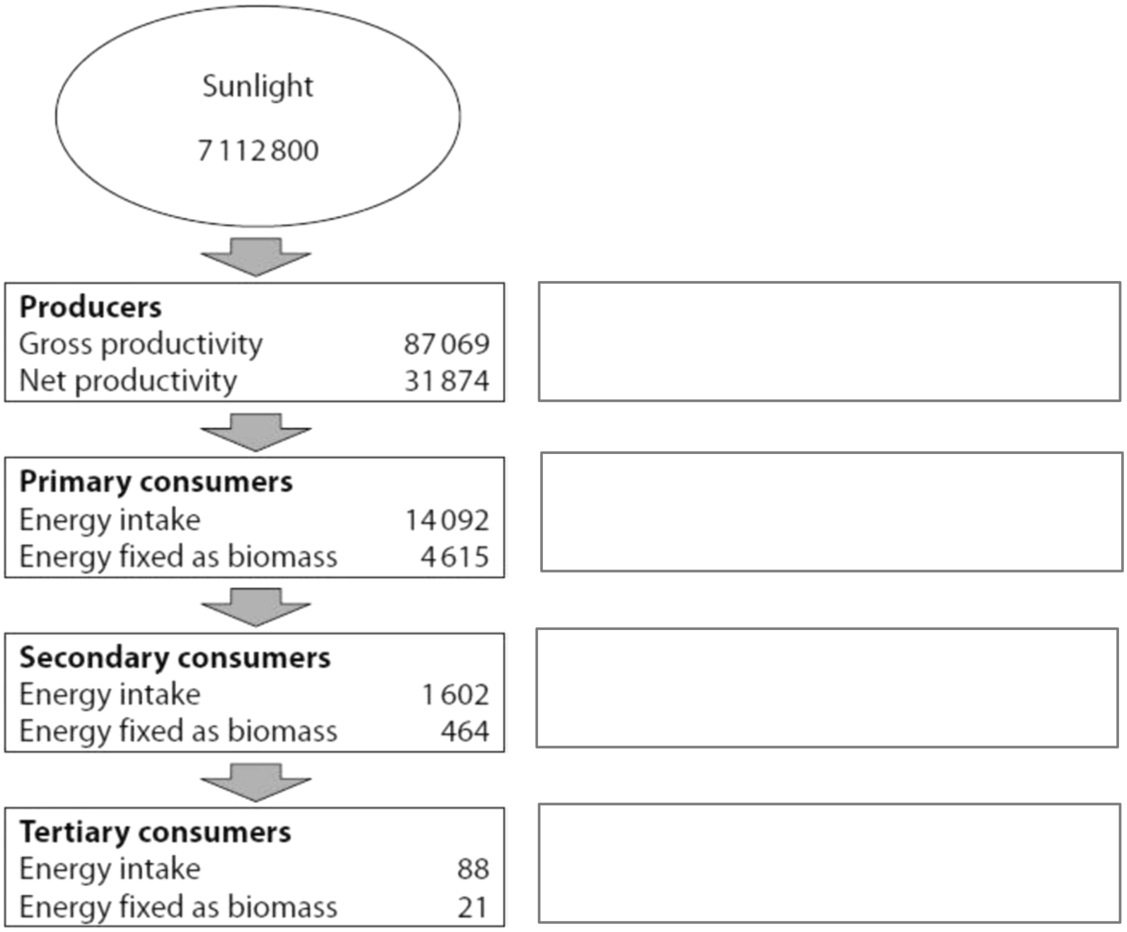
Assimilation efficiency is the amount of assimilation divided by the amount of energy ingested: $(A_n/I_n) \times 100$.

Net Production efficiency is the amount of consumer production divided by the amount of assimilation: $(Pn/An) \times 100$.

Aplication:

Exercice 1: The diagram shows the transfer of energy through an ecosystem food chain.

All values are given in kJ m^{-2} yr^{-1}.



1. Give (in the boxes) a second name and abbreviation for each type of energy in the diagram
2. Represent the food chain described above through an ecological pyramid.
3. Calculate how much energy is lost through respiration (R_0) by the primary producers.
4. Calculate the efficiency of photosynthesis
5. Calculate the exploitation efficiency of the primary, secondary and tertiary consumers.
6. Calculate the Ecological Efficiency (EE) of energy transferred between primary consumers and secondary consumers, and between secondary consumers and tertiary consumers.

Exercice 2:

Plants absorb 340000 kcal/m²/yr sunlight incident on a community in the region. The absorbed light results in a net plant production of 8833 kcal/m²/yr and evapotranspiration of 11977 kcal/m²/yr.

The herbivores consume 3368 kcal/m²/yr of plant mass and additional intake of 536 kcal/m²/yr from other sources respiring 1760 kcal/m²/yr of it. 1478 kcal/m²/yr die of natural causes. The remaining eaten up by the carnivores but they lose a further 216 kcal/m²/yr using energy for respiration.

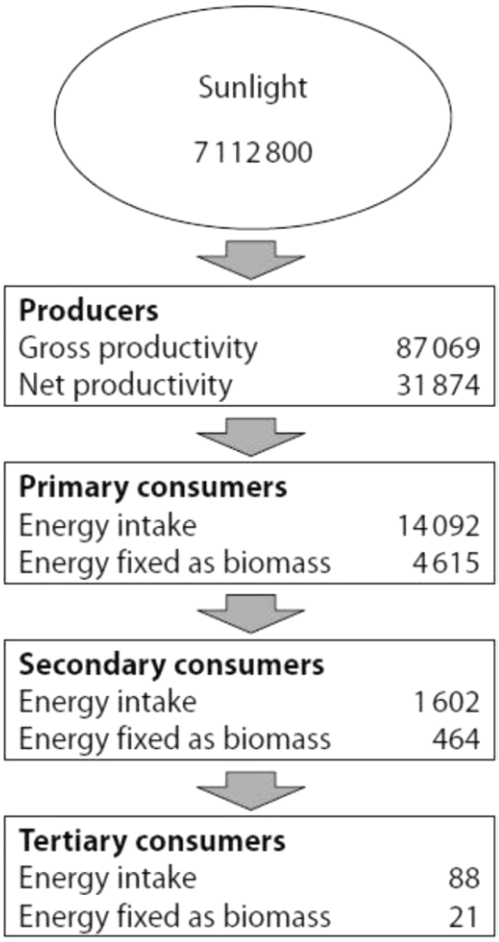
(i) Estimate the ecological efficiencies for the producers, primary and secondary consumers of this food chain.

(ii) Explain why the efficiency of energy transfer differs between different trophic levels.

Solution:

Exercice 1: The diagram shows the transfer of energy through an ecosystem food chain.

All values are given in kJ m^{-2} yr^{-1}.



- Gross Primary Productivity (GPP)
- Net Primary Productivity (NPP)

- Energy ingested by primary consumers (I1)
- Secondary productivity of primary consumers (SP1)

- Energy ingested by secondary consumers (I2)
- Secondary productivity of secondary consumers (SP2)

- Energy ingested by tertiary consumers (I3)
- Secondary productivity of tertiary consumers (SP3)

2. Energy pyramid: GPP (87069), NPP (31874), SP1 (4615), SP2 (464), SP3 (21) in kJ m^{-2} yr^{-1}

3. Calculation of energy lost through respiration (R_0) by the primary producers.

GPP = NPP + R_0

R_0 = GPP – NPP = 87069 – 31874 = 46195 kJ m^{-2} yr^{-1}.

4. Calculation of the efficiency of photosynthesis

(GPP/ Solar Energy) × 100 = (87069 / 7112800) × 100 = 1.22%

5. **Calculation of the Exploitation efficiency of the primary, secondary and tertiary consumers.**

- Primary consumer = Ingested energy (Intake) (I) /available energy = **(In/Pn-1) × 100**

= (I1/NPP) × 100 = (14092 / 31874) × 100 = 44.21%

- Secondary consumers = (In/Pn-1) × 100 = **(I2/ SP1) × 100** = (1602 / 4615) × 100 = 34.71%

- Tertiary consumers = (In/Pn-1) × 100 = **(I3/PS2) × 100** = (88 / 464) × 100 = 18.96%

6. Calculation of the Ecological efficiency:

EE = (production at present trophic level / production at previous trophic level) × 100

= $(P_n/P_{n-1}) \times 100$

- Between producers and primary consumer = **$(P_n/P_{n-1}) \times 100$ = (SP1/ NPP) × 100**

= (4615 /31874) × 100 = 14.47%

- Between secondary consumers and tertiary consumers = **(SP3/ SP2) × 100**= (20 /464) × 100

= 4.31%

Exercice 1:

(i) 1. Net productivity of each trophic level:

- Gross Primary Productivity of plants:

GPP = NPP + R0 = 8833 + 11977 = 20810 kcal/m²/yr.

-Secondary productivity (Net productivity of herbivores, carnivores):

-PS1= (3368+536) – 1760 = 2144 kcal/m²/yr.

-PS2 = (2144 – 1478) – 216 = 450 kcal/m²/yr.

(i) 2. Calculation of the Ecological efficiency:

EE = (production at present trophic level / production at previous trophic level) × 100

= $(P_n/P_{n-1}) \times 100$

- Efficiency of photosynthesis

(GPP/ Solar Energy) × 100 = (20810/ 340000) × 100 = 6.12%

- Between producers and herbivores = **$(P_n/P_{n-1}) \times 100$ = (SP1/ NPP) × 100**

= (2144 /8833) × 100 = 24.27%

- Between herbivores and carnivores = **(SP2/ SP1) × 100**= (450 /2144) × 100

= 20.98%

(ii) Explanation why the efficiency of energy transfer differs between different trophic levels:

Only a small proportion of the energy at one trophic level is passed on to the next. The rest is lost in the different ways:

Only 1 - 3% of the energy available to plants is converted into organic matter. This is because:

- Over 90% of the sun's energy is reflected back into space by the atmosphere.
- Not all wavelengths of light can be absorbed by plants in photosynthesis.
- Light may not actually fall of the chlorophyll molecule

Only approximately 10% of the energy stored in plants is passed on to primary consumers, secondary and tertiary consumers. The low amount of energy absorbed at each stage is due to:

- Some of the organism not being eaten
- Some parts are not consumed.
- Some parts can be eaten but not digested
- Some of the energy is lost as excretion and faeces
- Animals: primary consumers/secondary consumers have higher respiration rates than producers.
- Some of the energy is lost through (respiration / heat / movement); different organisms have different respiration -rates.

TW N 9: Movement of matter in ecosystems and major bio- geochemical cycles:

Concept of Biogeochemical Cycles

The cycling of nutrients from non-living to living components and back is one of the most important of ecosystem functions. Because this cycling involves living organisms (biology), geological processes (water movement, mountain building, erosion and soil properties) and chemical transformations, these cycles are termed **biogeochemical** cycles.

A biogeochemical cycle or substance turnover or cycling of substances is a pathway by which a chemical substance moves through both biotic (living components) and abiotic (lithosphere, atmosphere, and hydrosphere) compartments of Earth. A cycle is a series of change which comes back to the starting point and which can be repeated.

Types of biogeochemical cycles

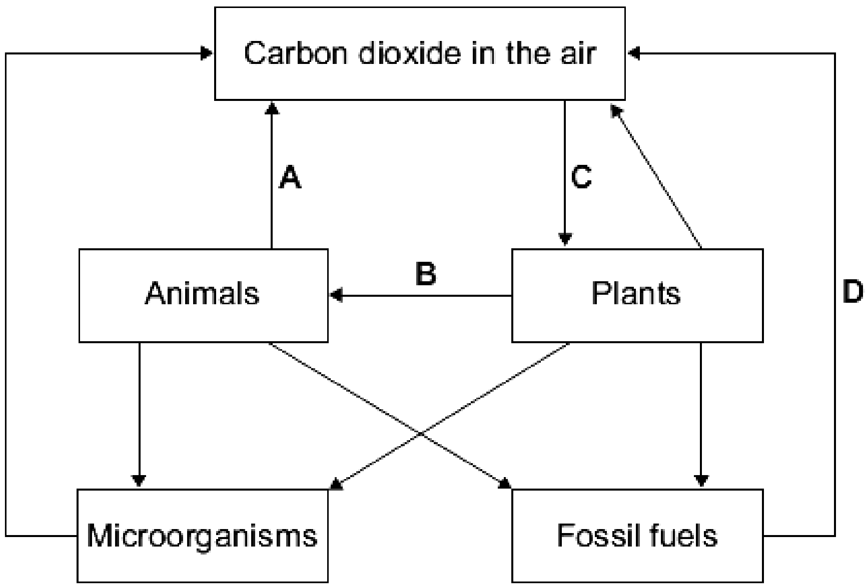
Three main types of biogeochemical cycles can be distinguished:

• The water cycle.

• The cycle of elements with predominant gas phase (carbon, oxygen, nitrogen).

• The cycle of elements with a predominant sedimentary phase (phosphorus, potassium, etc...)

Exercice 1: The diagram shows part of the carbon cycle.



Name the processes labelled **A**, **B**, **C** and **D**, on the diagram.

(a) In process **A**, carbon dioxide is released from plants and animals into the atmosphere. What is process **A**?

(b) In which process is carbon passed from one organism to another in process **B**?

(c) In process **C**, carbon dioxide in the atmosphere is taken into plants. What is process **C**?

(d) process **D** releases the stored carbon dioxide as fossil fuels (such as oil, coal, and natural gas), into the atmosphere. What is process **D**?

Exercice 2: Read each statement and place a check mark in the column of the cycle(s) it applies to:

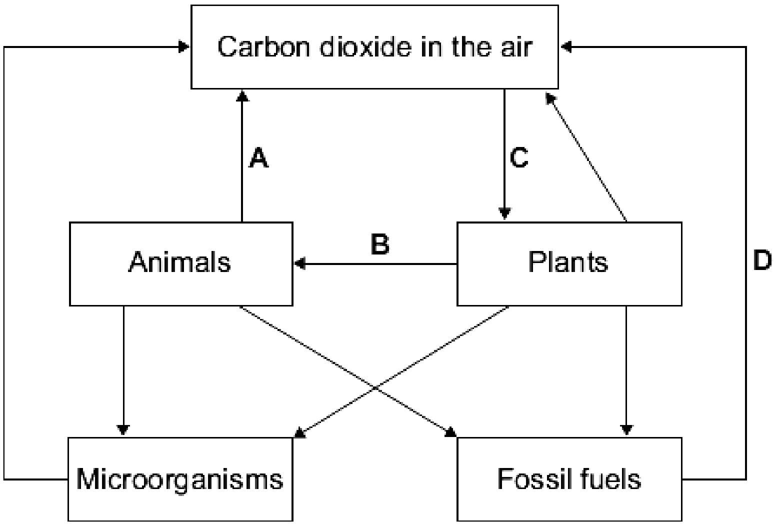
	Water	Carbon	Nitrogen	Phosophorus
1. Matter cycles through living and nonliving components of the ecosystem				
2. Cannot happen without decomposers like bacteria.				
3. Has stages that occur underground.				
4. Cycle which is dependent on bacteria for fixation and denitrification.				
5. Entire cycle is driven by the sun.				
1. Cycle in which photosynthesis and cellular respiration participate				
Only cycle which does not pass through the atmosphere				
Cycle that involves transpiration				
Cycle in which volcanic activity and burning fossil fuels plays a role.				

Exercice 3: Match the name of the stage to the correct description. Not all words will be used.

8. When water returns to the atmosphere via plants.	A. Evaporation
9. A step in the carbon cycle that didn't really exist before the industrial	B. Transpiration
revolution.	C. Condensation
10. When nitrogen gets captured from the atmosphere by bacteria.	D. Precipitation
11. Water is absorbed underground and can be stored in aquifers.	E. Runoff
12. Water is not absorbed underground but collects on the surface of the	F. Infiltration
earth.	G. Combustion
13. Fungi and bacteria return nutrients from dead organisms to the soil.	H. Photosynthesis
14. Bacteria in the roots of plants convert nitrogen into usable forms.	I. Cellular respiration
15. Organisms eat other organisms as a food source.	J. Consumption
16. Organisms capture sunlight and store the solar energy as chemical	K. Decomposition
energy in molecules like carbohydrates.	L. Fossilization
17. When nitrogen is returned to the atmosphere by bacteria as N_2.	M. Nitrogen fixation
18. Water falls from the sky as snow, sleet, or rain.	N. Ammonification
19. When organisms breakdown carbon-based molecules for energy and	0. Denitrification
release CO_2 as a result.	P. Nitrification

Solution

Exercice 1: The diagram shows part of the carbon cycle.



(a) In process **A**, carbon dioxide is released from plants and animals into the atmosphere.
What is process **A**? **A: Respiration.**

(b) In which process is carbon passed from one organism to another in process **B**? **B: Feeding .**

(c) In process **C**, carbon dioxide in the atmosphere is taken into plants. What is process **C**?
C: **Photosynthesis.**

(d) process **D** releases the stored carbon dioxide as fossil fuels (such as oil, coal, and natural gas), into the atmosphere. What is process **D**? **D: Combustion / Burning.**

Exercice 2: Read each statement and place a check mark in the column of the cycle(s) it applies to:

	Water	Carbon	Nitrogen	Phosophorus
1. Matter cycles through living and nonliving components of the ecosystem	X	X	X	X
2. Cannot happen without decomposers like bacteria.		X	X	
3. Has stages that occur underground.	X	X	X	X
4. Cycle which is dependent on bacteria for fixation and denitrification.				X
5. Entire cycle is driven by the sun.	X			
6. Cycle in which photosynthesis and cellular respiration participate		X		
7. Only cycle which does not pass through the atmosphere				X
8. Cycle that involves transpiration	X			
9. Cycle in which volcanic activity and burning fossil fuels plays a role.		X		

Exercice 3: Match the name of the stage to the correct description. Not all words will be used.

8. **B** When water returns to the atmosphere via plants. 9. **G** A step in the carbon cycle that didn't really exist before the industrial revolution. 10. **M** When nitrogen gets captured from the atmosphere by bacteria or even lightning. 11. **F** Water is absorbed underground and can be stored in aquifers. 12. **E** Water is not absorbed underground but collects on the surface of the earth. 13. **K** Fungi and bacteria return nutrients from dead organisms to the soil. 14. **P** Bacteria in the roots of plants convert nitrogen into usable forms, such as NO_2. 15. **J** Organisms eat other organisms as a food source. 16. **H** Organisms capture sunlight and store the solar energy as chemical energy in molecules like carbohydrates. 17. **O** When nitrogen is returned to the atmosphere by bacteria as N_2. 18. **D** Water falls from the sky as snow, sleet, or rain. 19. **I** When organisms breakdown carbon-based molecules for energy and release CO_2 as a result.	A. Evaporation B. Transpiration C. Condensation D. Precipitation E. Runoff F. Infiltration G. Combustion H. Photosynthesis I. Cellular respiration J. Consumption K. Decomposition L. Fossilization M. Nitrogen fixation N. Ammonification O. Denitrification P. Nitrification

TW N 10: IMPACT OF HUMAN ACTIVITIES ON BIOLOGICAL BALANCES:

Human Impact on Biogeochemical Cycles

Human activities have significantly altered biogeochemical cycles, leading to environmental challenges:

The hydrological cycle: Water cycle has been harmed by deforestation has led to surface run off, which enters into the streams or rivers and immediately causes floods.

Carbon Cycle: The carbon cycle and the nitrogen cycle have been adversely affected by burning of fossil fuels, which has caused global warming and further damaged the ozone hole. The burning of fossil fuels and deforestation increase atmospheric CO2, contributing to climate change.

Nitrogen Cycle: The use of synthetic fertilizers and fossil fuels elevates nitrogen levels, causing eutrophication and air pollution. Excessive nitrogen levels have caused pollution in the fresh waters and coastal zones, and may contribute to climate change.

Phosphorus Cycle: Mining and agriculture increase phosphorus runoff, leading to water quality issues.

Sulfur Cycle: Industrial processes release sulfur compounds, contributing to acid rain and air pollution.

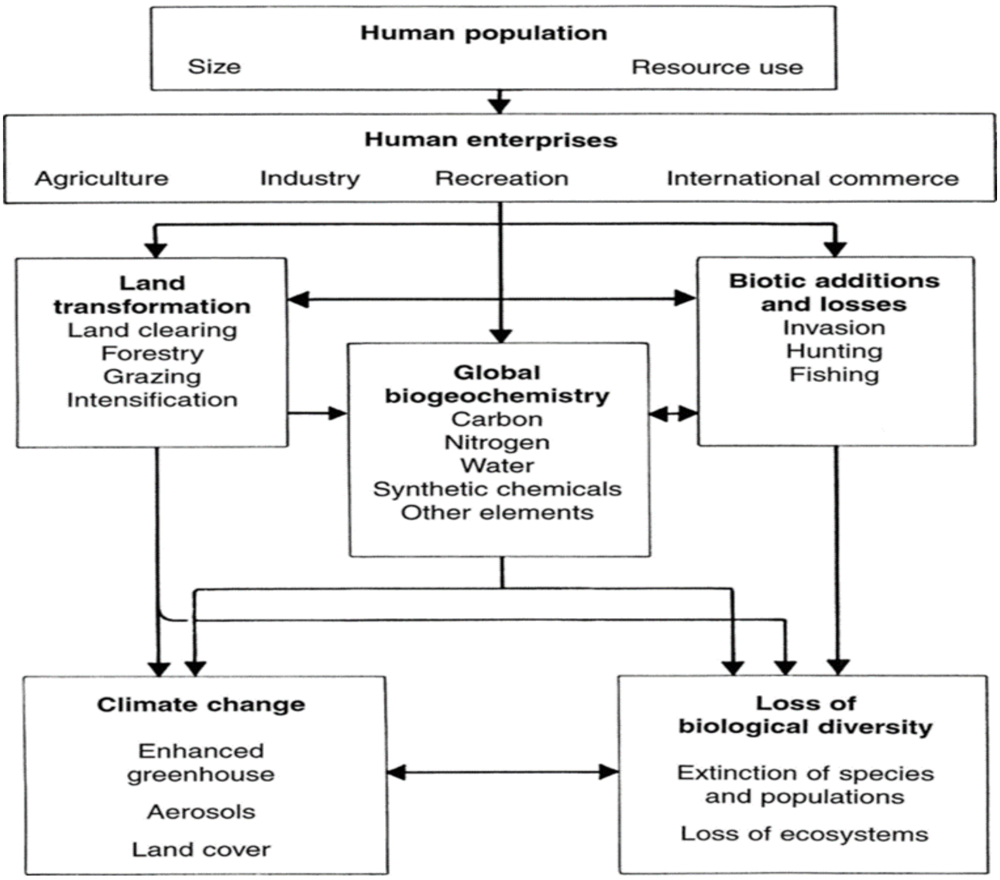


Fig. 1. A schematic of the direct and indirect effects of humans on Earth's ecosystems. (Reprinted with permission from Vitousek *et al*. (1997) Human domination of earth's ecosystems.

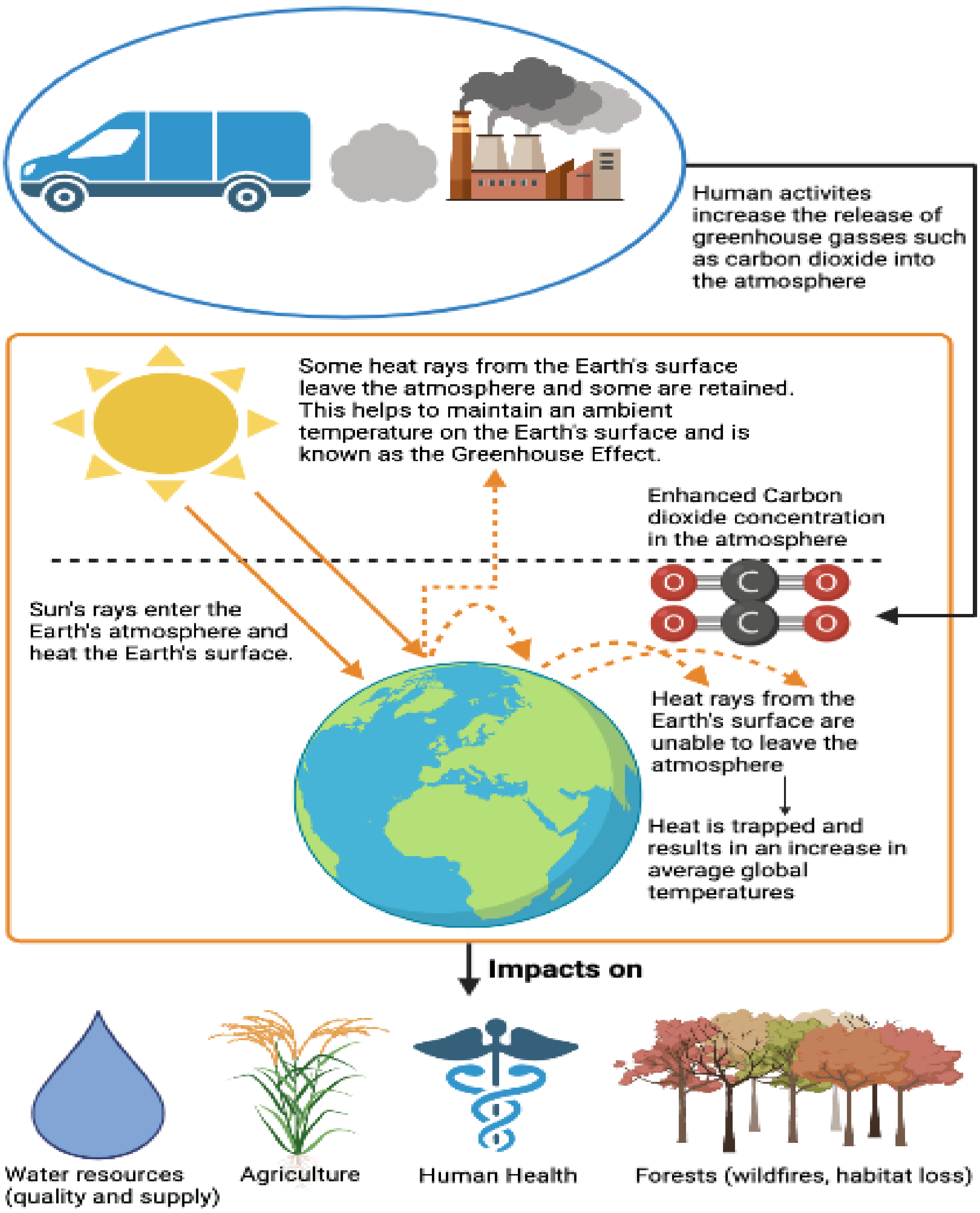
Exercice 1: Complete the table by choosing which type of effect is most anticipated given the cause. Determine if that leads to an increase or decrease in biodiversity. Remember, **Biodiversity** refers to all the different types of organisms that live on our planet.

Human activity	**Effect**	**↑ Or ↓ Biodiversity**
Overhunting		
Deforestation		
Heavily Fertilizing Crops		
Conservation		
Ocean Oil Spills		
Replanting Trees		
Dangerous Pesticide Use		
Habitat Management		

Exercice 2: List an example of human impact on Biogeochemical cycles.

Biogeochemical cycles	**Human impact**	**Human activity**
Water cycle		
Carbon cycle		
Nitrogen cycle		
Phosphorus cycle		
sulphur cycles		

Exercice 3: Use this material to answer questions



1. Identify the name given to the phenomenon whereby the Earth's atmosphere traps the Sun's heat.

2. Which greenhouse gas that has significantly contributed to climate change from the options listed below.

3. What will happen to the concentration of carbon dioxide in the atmosphere if lots of trees are cut down?

4. A city with a high population density experiences air pollution due to vehicle emissions and industrial activities. How might this urban pollution affect the nitrogen cycle in the local ecosystem?

SOLUTION:

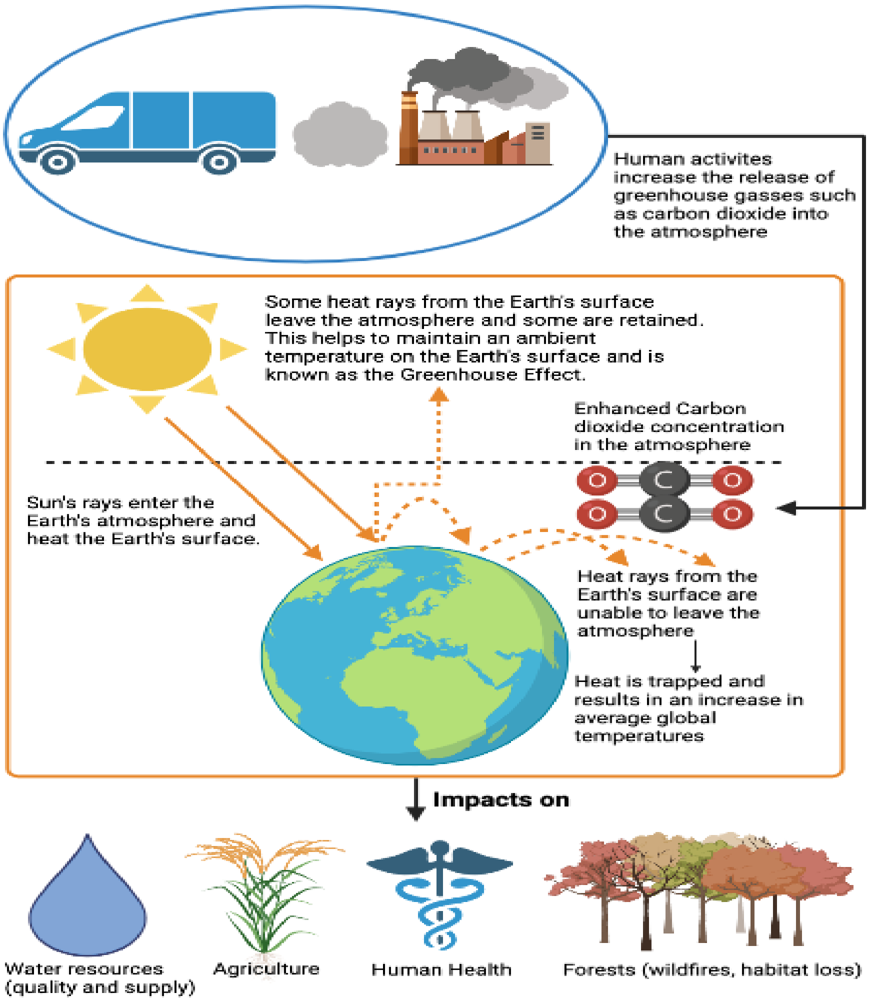
Exercice 1: Complete the table by choosing which type of effect is most anticipated given the cause. Determine if that leads to an increase or decrease in biodiversity.

Human activity	**Effect**	**↑ Or ↓ Biodiversity**
Overhunting	a major contributor to the mass extinctions.	↓
Deforestation	increase the concentration of carbon dioxide in the atmosphere	↓
Heavily Fertilizing Crops	Soil and fresh water pollution	↓
Conservation	Preserving endangered species.	↑
Ocean Oil Spills	culprits of water pollution and ocean toxicity.	↓
Replanting Trees	increase the concentration of Oxygen and decrease the concentration of carbon dioxide in the atmosphere	↑
Dangerous Pesticide Use	Contaminate soil, water, turf, and other vegetation.	↓
Habitat Management	Conservation of wild flora and fauna.	↑

Exercice 2: List an example of human impact on Biogeochemical cycles.

Biogeochemical cycles	**Human impact**	**Human activity**
Water cycle	Pollution	Contamination: presence or introduction of unwanted materials into the water
Carbon cycle	Green House Effect Global climate change	Burning fossil fuels and from the clearing of forests, coal-burning power plants, automobile exhausts, factory smokestacks, and other waste.
Nitrogen cycle	Eutrophication and air pollution	Fertilizers, biomass burning, cattle and feedlots, and other industrial sources
Phosphorus cycle	Phosphorus runoff and fresh water pollution	Mining and agriculture (Fertilization)
Sulphur cycles	Industrial air pollution, acid rain and air pollution	Combustion of fossil fuels, Industrial processes release sulfur compounds.

Exercice 3: Use this material to answer questions



1. Identify the name given to the phenomenon whereby the Earth's atmosphere traps the Sun's heat.

Answer: Greenhouse Effect

2. Which greenhouse gas that has significantly contributed to climate change from the options listed below.

Answer: Carbon dioxide

3. **What will happen to the concentration of carbon dioxide in the atmosphere if lots of trees are cut down?**

Answer: Forests help regulate the climate by absorbing carbon dioxide. They also provide oxygen and support countless species of plants and animals.

When forests are cleared or burnt, stored carbon is released into the atmosphere, mainly as carbon dioxide. When deforestation affects the carbon cycle, there is less carbon being absorbed and more staying in the atmosphere, which affects how the Earth's climate is regulated and

4. A city with a high population density experiences air pollution due to vehicle emissions and industrial activities. How might this urban pollution affect the nitrogen cycle in the local ecosystem?

Answer: Urban pollution, particularly nitrogen dioxide (NO_2) emissions from vehicles and industrial sources, can lead to elevated nitrogen deposition in the local environment. This excess nitrogen can accelerate nitrification, a process in the nitrogen cycle that converts ammonia and ammonium compounds into nitrates. This can disrupt the natural balance of nitrogen compounds in the soil and impact nutrient availability for plants.

References

BONIN G. 1982. Ecologia mediterranea, revue d'écologie terrestre et limnique. TOME VIII, MARSEILLE Cedex 4. France. P: 495.

Chapman, J. L. and Reiss, M. J. 1995. Ecology, Principles and Application. Second Edition, Cambridge University Press, UK. 330p

Charles J. Krebs. 2014. Ecology: The Experimental Analysis of Distribution and Abundance, Sixth Edition, Pearson Education Limited. Printed in the United States of America. 587 P.

Manahan S. E. 2001. Environmental science, technology, and chemistry" Environmental Chemistry Boca Raton: CRC Press LLC, 743 p.

Michael Begon, Colin R. Townsend and John L. Harper. 2006.-Ecology From Individuals to Ecosystems. Fourth Edition, Blackwell Publishing. 759 p.

Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Cengage Learning India

Private Limited.

Richard T. Wright, Bernard J. Nebel. 2002. Environmental Science, Pearson Education. 681 p.

Ricklefs R.E..2000. Ecology. V Edition. Newton, Massachusetts, Chiron Press. Pp 861.

Henaoui S. A. and Bouazza M. 2014. The bioclimate of Tlemcen area (Northwest Algeria). International Journal of Advanced Research, Volume 2, Issue 4, 669-693

Smith, T. M. & Smith, R. L. 2009. Elements of Ecology 7th ed. San Francisco CA: Pearson Benjamin Cummings. 704 p.