Environmental Microbiology

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2-1	• تعريف وفكرة عن البيئة • تعريف وفكرة عن الاحياء الدقيقه
4-3	• تعريف وشرح البيكتيريا • تعريف وشرح الفطريات
6-5	• تعريف وشرح الطحالب • تعريف وشرح البروتوزوا
7	• الاختبار النصفي
9-8	• تعريف وشرح الفيروسات • التعقيم والتحكم
11-10	• الاحياء الدقيقه في الاغذية • الاحياء الدقيقه في المياه
13-12	• الاحياء الدقيقه في التربه • الاحياء الدقيقه في الهواء
14	• العرض التدريبي • الاختبار النهائي

Environmental Microbiology (802223-3) III YEAR Environmental Engineering

Second Semester (1439-40H) MALE STUDENTS

Lecture:

Tuesday 01.00-02.50am – Eng. Room 325

Lecturers: Dr. Anas S. Dablool

Practical:

Sunday: 3.00 - 4.50 pm

Lecture No.	Date	Title	Lecturer	Practicals
1	23/12/1438H 04/09/2018G	Beginning of First Semester		Opening Meeting- course over view
2	30/12/1439H 11/09/2018G			Introduction, history of microbiology-Fundamentals of microbiology
3	08/01/1440H 18/09/2018G		1	Eukaryotes and prokaryotes cells ,characteristics of microorganisms
4	15/01/1440H 25/09/2018G		2	Microbial Diversity and Metabolism Microbial nutrition, growth and control
5	22/01/1440H 02/10/2018G		3	Bacteria, taxonomy ,cell structure and function nutrition, growth and control
6	29/01/1440H 09/10/2018G	FIRST PERIODIC EXAMINATION	4	Fungi, taxonomy ,cell structure and function nutrition, growth and control
7	07/02/1440H 16/10/2018G		5	Viruses taxonomy , structure and function nutrition, growth and control
8	14/03/1440H 23/12/2017G		6	
9	21/02/1440H 30/11/2018G		7	Algology taxonomy cell structure function nutrition growth and control
10	28/02/1440H 06/11/2018G		8	Microbial Diseases and their control
11	05/03/1440H 13/11/2018G	SECOND PERIODIC EXAMINATION	9	Introduction to the laboratory equipments , sterilization, media.
12	12/03/1440H 20/11/2018G		10	Introduction to the laboratory equipments , staining, Disinfection
13	19/03/1440H 27/12/2018G		11	Ecology and Symbiosis
14	26/03/1440H 04/12/2018G		12	Food & industrial microbiology
15	04/04/1440H 11/12/2018G	Water and Wastewater Microbiology Soil Microbiology		
16	11/04/1440H 18/12/2018G	Beginning of Final Exam for first Semester		
17	18/04/1440H 25/12/2018G	Upload of First Semester results		

Lecture (1) Introduction to Ecology

Environmental Microbiology

1. Introduction to Environment
2. Introduction to microbiology
3. History and scope
4. Microbial structure and function, nutrition, growth, effects of environmental factors on bacterial growth
5. Control of microorganisms by physical and chemical agents
6. The diversity of the microbial world
7. microbial taxonomy
8. Interactions and microbial ecology
9. Human diseases caused by bacteria
10. Food and industrial microbiology
11. Water microbiology, soil microbiology
12. Introduction to the laboratory equipments and materials, sterilization techniques, preparation of media, staining methods

Environmental Microbiology

Microbial ecology: definition
is the ecology of microorganisms: . It concerns- their relationship with one another and with their environment
Microbial Ecology –
The science that explores interrelationships between organisms and their living and abiotic environment

Environmental Microbiology –
The study of microbial fate and activity in air, water and soil, and the resulting impact on human health and welfare.

Microbial Ecology & Environmental Microbiology

The study of microbes & their processes in vivo:

- What is an ecosystem?
- Are all ecosystems colonised by microbes?
- What do we know about numbers & diversity of microbes in nature?
- Do they live in isolation and or do they interact?
- How many microbial species are there
- Can we culture them all in the laboratory

What is ecology?

Ecology is the science by which we study how organisms (animals, plants, microbes) interact in and with the natural world.

Robert E. Ricklefs. 1997. *The Economy of Nature 4th ed*. W.H. Freeman and Company. New York.

- The study of living organisms in the natural environment
- How they interact with one another
- How the interact with their nonliving environment

Environment

- Biotic components (Living)
  - All need sun, air, water, and earth
  - All grow, eat, drink, breathe, move, have babies
- A biotic components(Non-living)

Habitat

- Where something lives
- Can be defined as a big or small area
  - A small pool
  - Pacific Ocean

Classification of Living Things

- 7 levels of classification: kingdom, phylum, class, order, family, genus, species.
- Kingdom plantae is composed of multi-celled organisms that grow from embryos (seeds)that are usually the result of sexual fusion of a male and female cell.
- Kingdom animalia is comprised of multi-celled organisms which develop from an embryo resulting from the fertilization of an egg by a much smaller sperm.

Relationships

How do populations interact?

- Predation
- Competition
- Co-operation
- Symbiotic relationships
  - Parasites
  - Mutualist
  - Commensualists

Adaptations

- Any physical or behavioral feature that helps an organism survive.
  - teeth shapes
  - Camouflage vs. bright coloring
  - Habitat adaptations

Food Chains

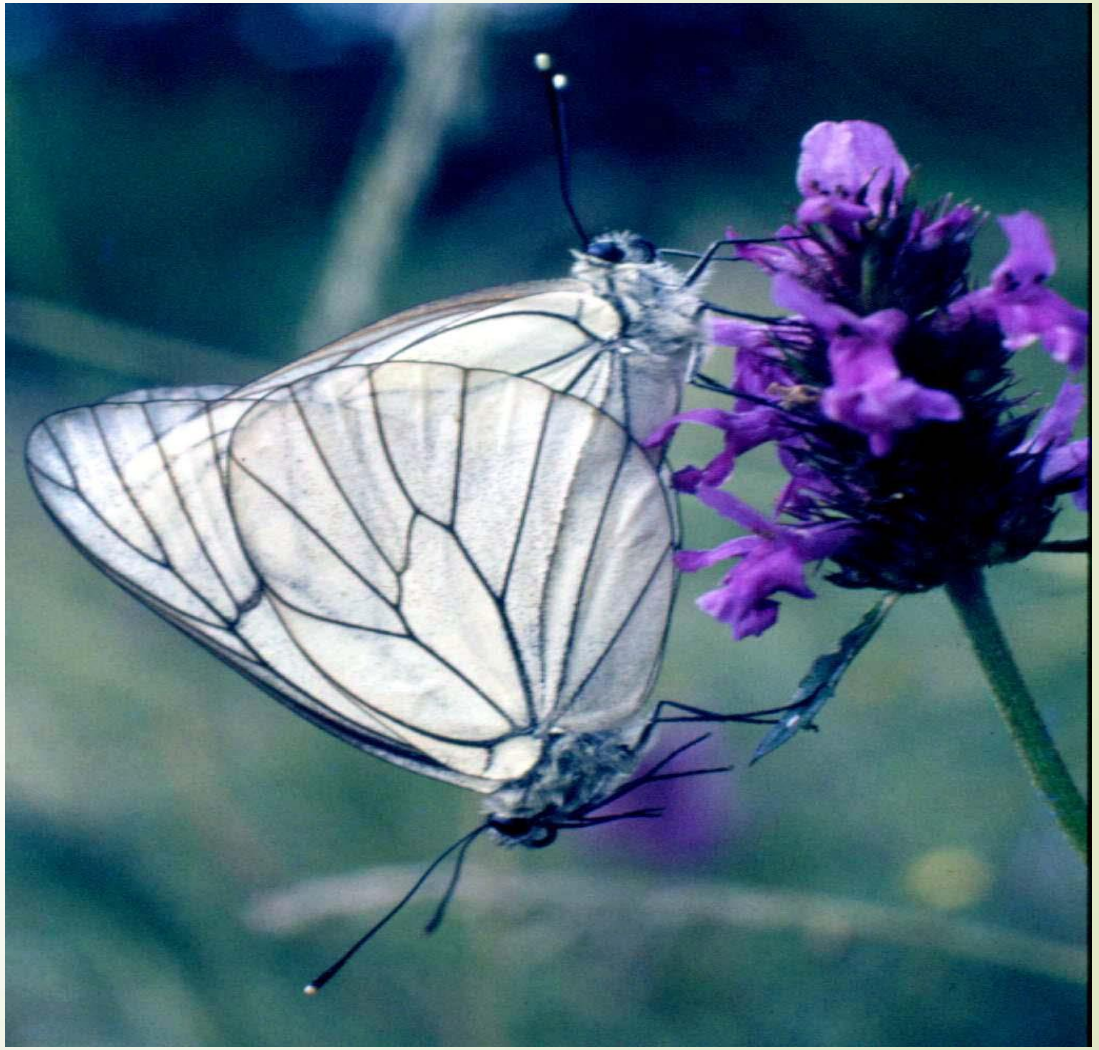
- Parts of a food chain:
  - Producers —make their own food
  - Primary Consumers—eats producers
  - Secondary Consumers—eat other consumers
  - Decomposer—"eats" and breaks down dead material

Ecosystem

Community + Abiotic environment, interacting

Population

A group of organism of the same species which live in the same habitat at the same time where they can freely interbreed



Biodiversity

The total number of different species in an ecosystem and their relative abundance

Worcester City Museums

Species

A group of organisms that can breed to produce - fully fertile offspring

Great White Pelican *Pelecanus onocrotalus*

Community

All the populations of the different species living and inter-acting in the same ecosystem

Habitat

The characteristics of the type of environment where an organism normally lives.

Energy and organisms

Autotrophs

Organisms which can synthesise their own complex, energy rich, organic molecules from simple inorganic molecules

(e.g. green plants synthesis sugars from CO_2 and H_2O)

Heterotrophs

Organisms who must obtain complex, energy rich, organic compounds form the bodies of other organisms (dead or alive)

Detritivores

Heterotrophic organisms who ingest dead organic matter.

an animal that feeds on dead organic material, especially plant detritus (e.g. earthworms

Earth worm
(Lumbricus terrestris)

Saprotrophs

Heterotrophic organisms who secrete digestive enzymes onto dead organism matter and absorb the digested material. (e.g. fungi, bacteria)

Chanterelle

Feeding relationships

- Predators & prey
- Herbivory
- Parasite & host
- Mutualism
- Competition

Types of symbioses

- **Neutralism** - the populations, existing in one biotope do not stimulate and do not oppress each other.
- **Mutalism** - mutually advantageous cohabitation; one population synthesizes materials (matter), which are the basis of power supply for another (for example, legume bacteria and bean plants, aerobic and anaerobic bacteria in an organism of the man).
- **Commensalism** - such form of symbiosis, at which one of jointly living populations extracts for herself advantage(benefit), but does not put a harm of other population. The commensalism is characteristic for many inhabitants of human body.
- **Antagonism** - oppression of one population another. The microbes – antagonists produce antibiotics, bacteriocines, fatty acids, which cause destruction of bacteria or delay their reproduction.
- **Parasitism** - such kind of symbiosis, at which one population (parasite) brings harm to the host, and for itself has a benefit. The causative agents of bacterial, virus and fungic illnesses concern to microbes - parasites.

The place of an organism in its environment

Niche

An organism's habitat + role + tolerance limits to all limiting factors

THE COMPETITIVE EXCLUSION PRINCIPLE

G.F. Gause (1934)

If two species, with the same niche, coexist in the same ecosystem, then one will be excluded from the community due to intense competition

The Niche

- A niche is the role of a species in their environment. No two species hold the EXACT same niche
  - Shore birds (same place, different prey)
  - Eastern and Western bluebirds (same role, different place)

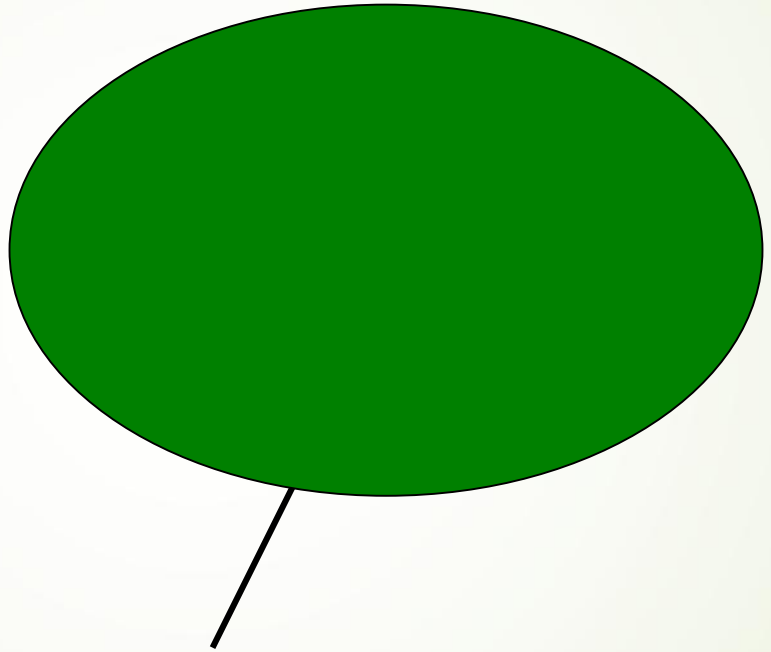
Niche

The niche of a species consists of:

- Its role in the ecosystem (herbivore, carnivore, producer etc)
- Its tolerance limits (e.g. soil pH, humidity)
- Its requirements for shelter, nesting sites etc etc, all varying through time

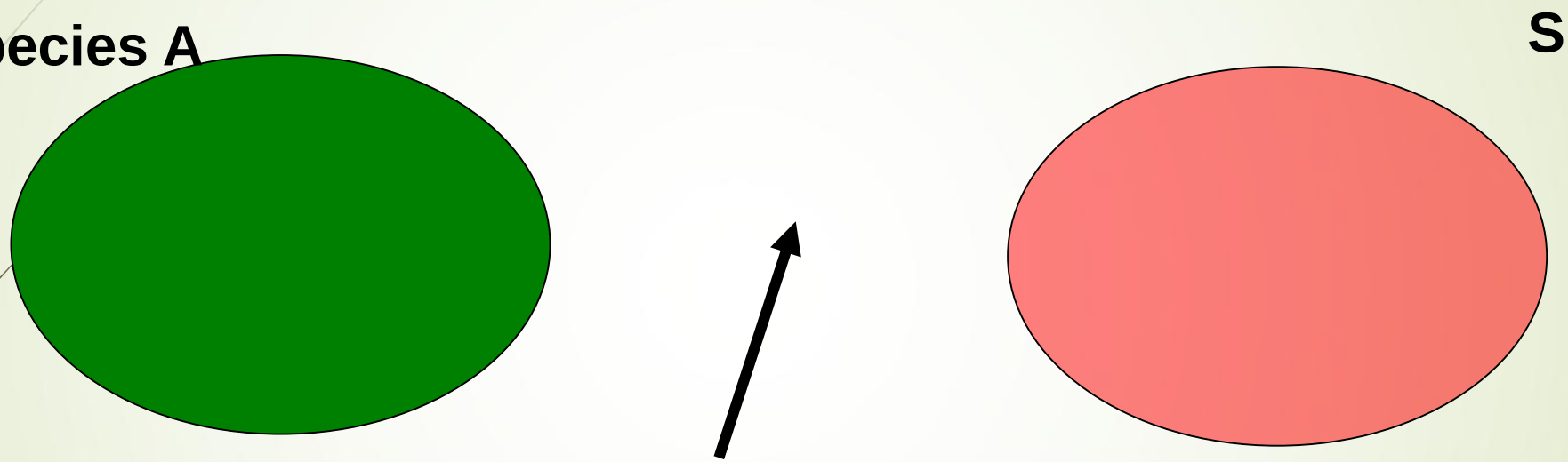
The niche as a two-dimensional shape

Species A



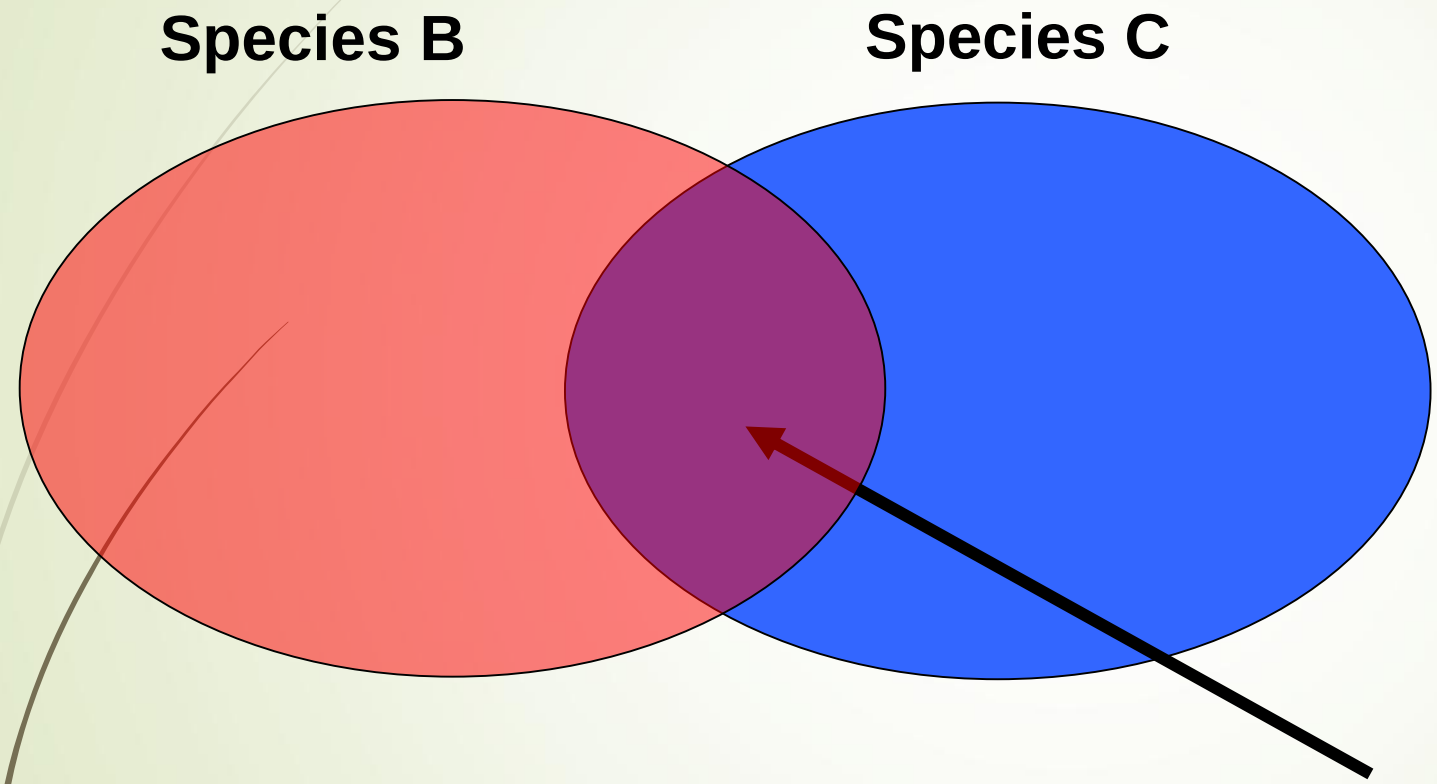
Niche represented by a 2-dimensional area

Separate niches



No overlap of niches.
So **coexistence** is possible

Overlapping niches



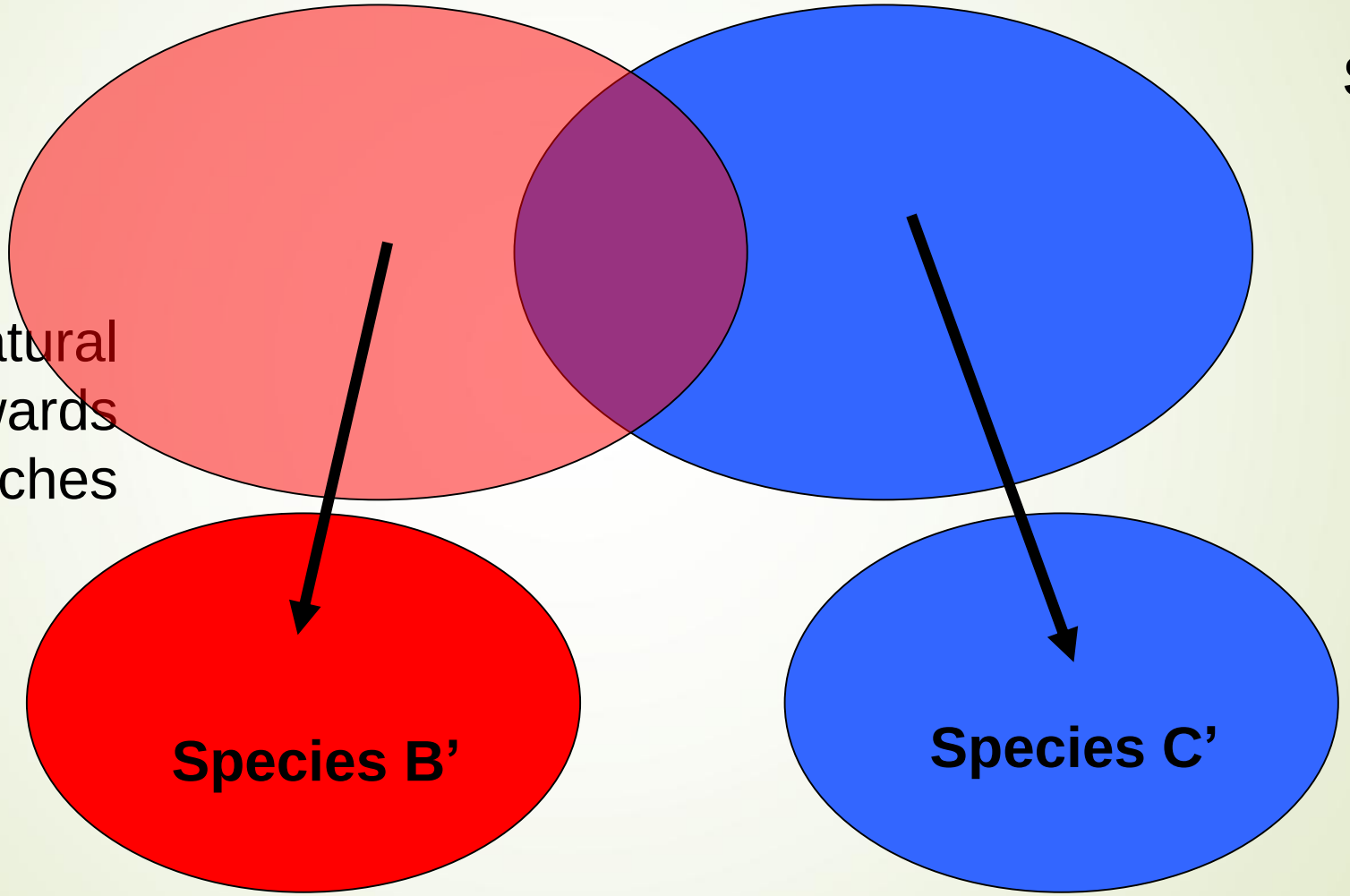
Interspecific competition occurs where the niches overlap

Specialisation avoids competition

Species B

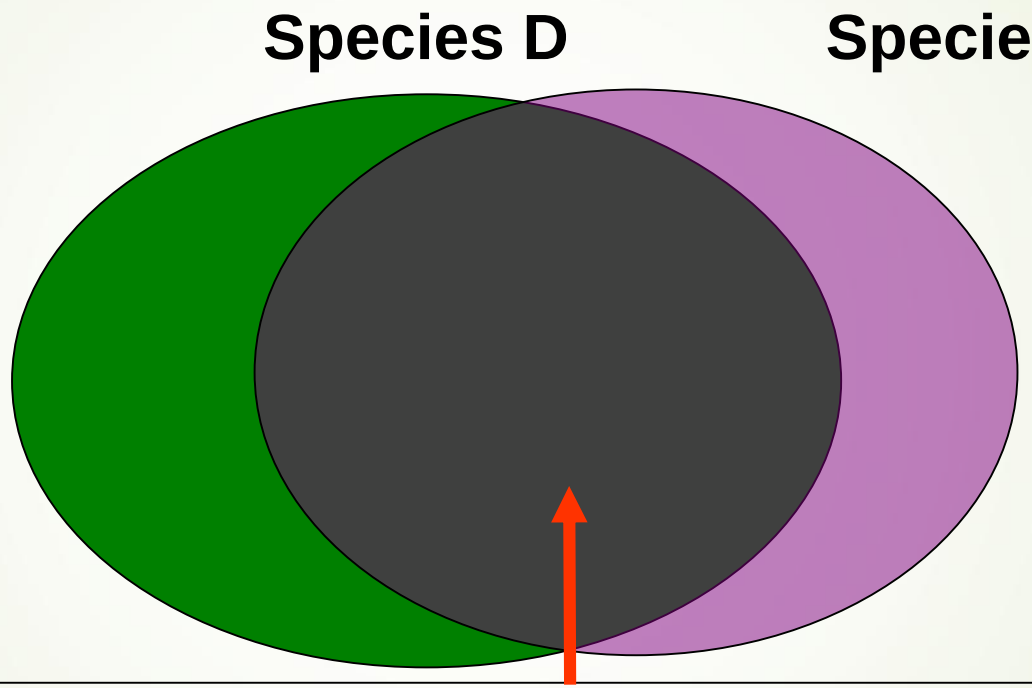
Species C

Evolution by natural selection towards separate niches



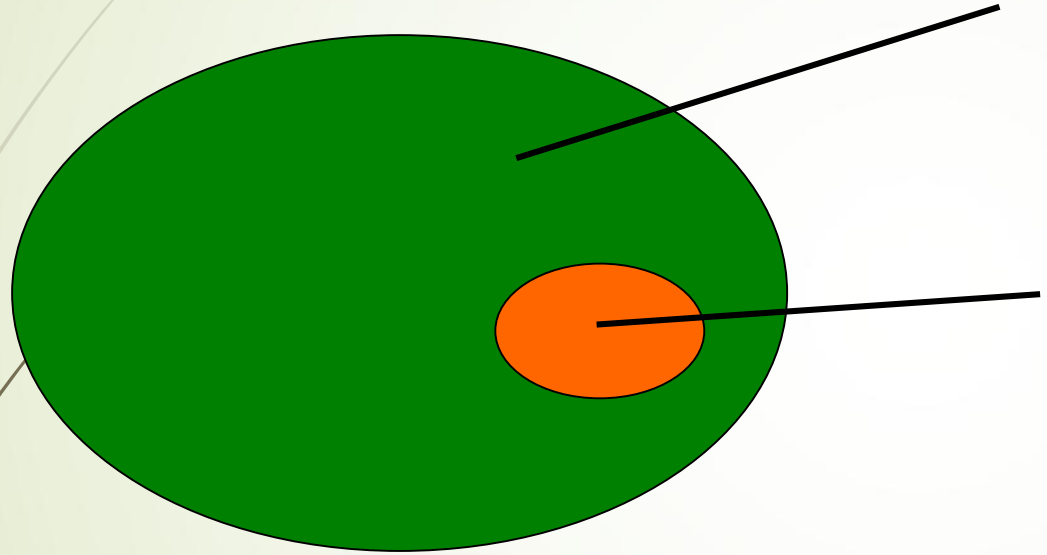
Specialisation into two separate niches

This niche is not big enough for the both of us!



Very heavy competition leads to **competitive exclusion**
One species must go

Total exclusion



Species A has a bigger niche
it is more generalist

Species E has a smaller niche it is more specialist
Specialists, however, do tend to avoid competition
Here it is total swamped by Species A

Human Ecology

- Human beings have a unique interaction with our environment.
  - Tool-use became technology
  - Communication became language
  - Produce garbage
  - Move beyond ecological constraints

Sustainability Principals

- Preserving
- Restoring
- Practicing
- Conserving
- Understanding
- Possible!

naking visible the invisible!

RIO TINTO, SPAIN

...making visible the invisible!

LAKE CISO, SPAIN

PURPLE SULFUR BACTERIA

Sometimes we cannot see them, but we can count them

Biomass of Microbes in the Biosfere

Habitat	Population size (cells)
Oceans	1.2×10^{29}
Soil	2.6×10^{29}
*Subsurface	4.9×10^{30}
Global	5×10^{30}

Whitman et al. PNAS 1998

*terrestrial habitats below 8 m (grounwater included) and marine sediments below 10 cm

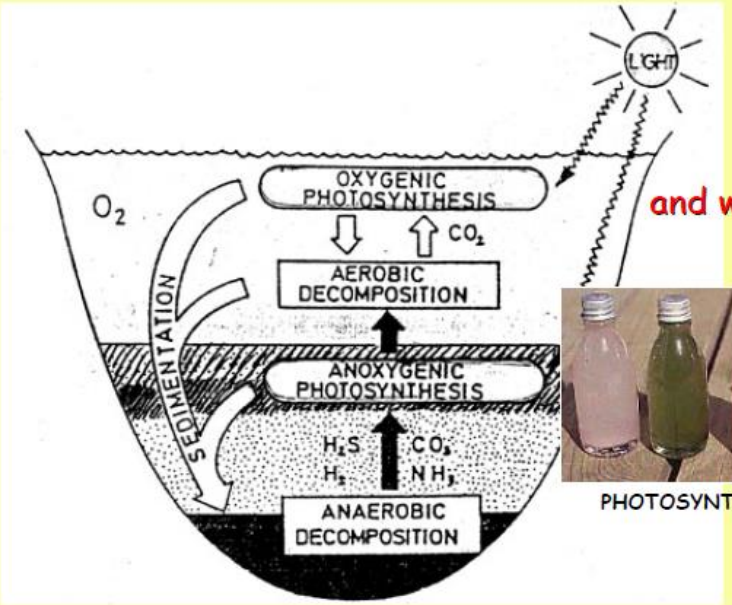
Biomass of Microbes in the Biosphere

Habitat	Population size (cells)	Biomass (Pg of C)	Plant Biomass (Pg of C)
Oceans	1.2×10^{29}	4	0
Soil	2.6×10^{29}	26	560
Subsurface	4.9×10^{30}	325-520	0
Global	5×10^{30}	350-545	562

Whitman et al. PNAS 1998

1 Pg = 10^{15} g

sometimes they have conspicuous colors in pure cultures...



and we can see them easily ...

PHOTOSYNTHETIC SULFUR BACTER

Understanding the distribution and basic ecology of one of the most abundant and diverse groups of organisms on Earth is still a unsolved issue in environmental research

Some of the aims of the microbial ecologists are…

- to determine how many different microbial species are out there,
- to find out what they can do,
- and to provide the know-how to identify environments of high and low microbial diversity

Very simple questions for microorganisms…but a very hard task for microbial ecologists!

Microorganisms

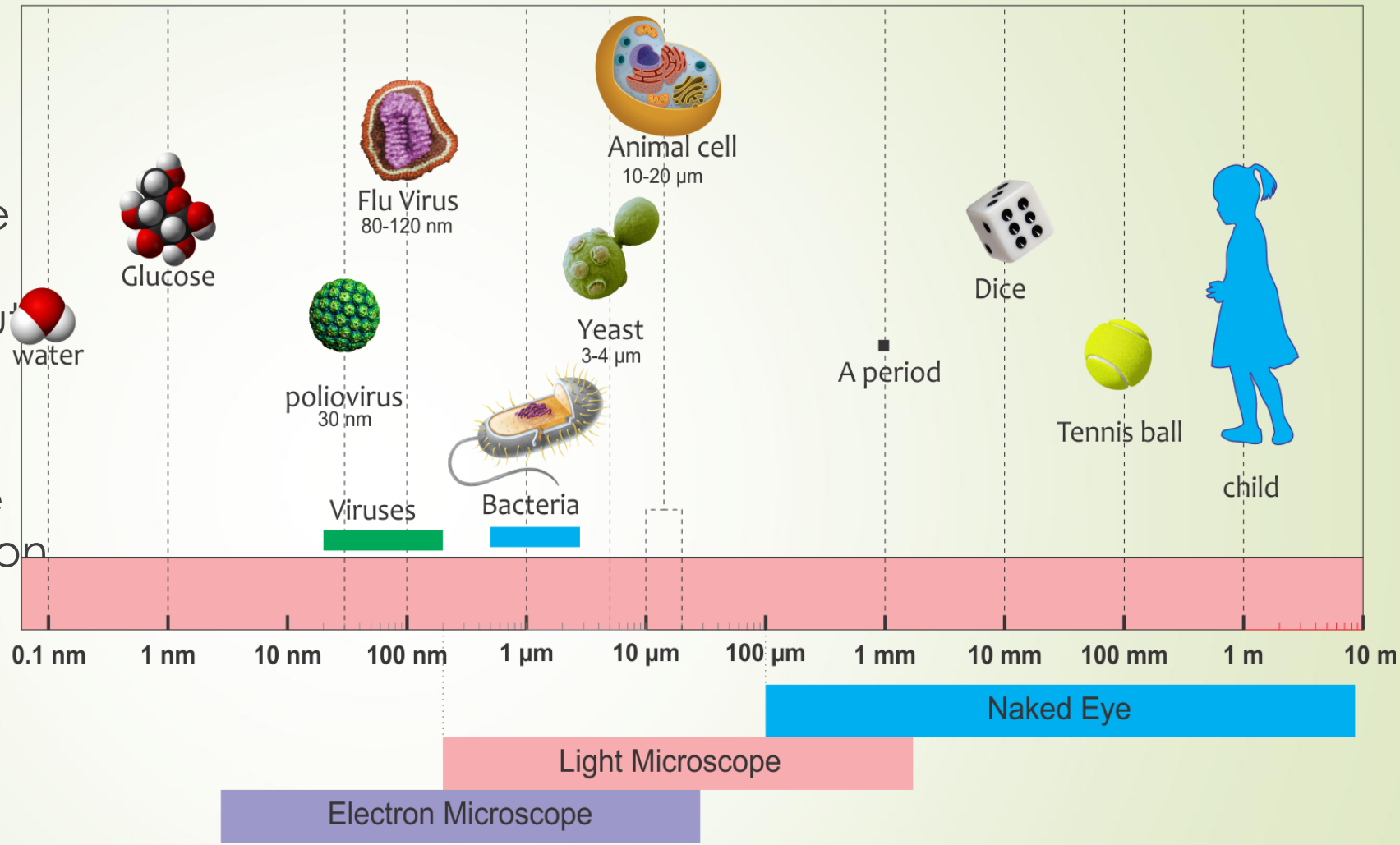
Microbiology:

- Microbiology is a science that deals with the study of living organisms that can not be seen by the naked eye. These can be seen with the aid of microscopes, which magnify objects. Many scientists contributed to the science of microbiology.

- **It Is the science that deals with microorganisms**

- (mikros = small bios = life Logos = science).

- An object must measure about 100 micrometers (μm) to be visible without a microscope.
- Note that fungi (yeast), bacteria and viruses are outside the range of vision of naked eye.
- [1 μm = 0.001 mm]



Relative sizes on a logarithmic scale, from 0.1 nm to 1 m.

This picture shows the tip of a surgical needle (shown in purple) contaminated with bacteria (shown in yellow).

Linnaeus 1735[34]	Haeckel 1866[35]	Chatton 1925[36]	Copeland 1938[37]	Whittaker 1969[38]	Woese et al. 1990[39]	Cavalier-Smith 1998[40]	Cavalier-Smith 2015[41]
2 kingdoms	3 kingdoms	2 empires	4 kingdoms	5 kingdoms	3 domains	2 empires, 6 kingdoms	2 empires, 7 kingdoms
(not treated)	Protista	Prokaryota	Monera	Monera	Bacteria	Bacteria	Bacteria
					Archaea		Archaea
		Eukaryota	Protoctista	Protista	Eucarya	Protozoa	Protozoa
						Chromista	Chromista
Vegetabilia	Plantae		Plantae	Plantae		Plantae	Plantae
				Fungi		Fungi	Fungi
Animalia	Animalia		Animalia	Animalia		Animalia	Animalia

Main article: Kingdom (biology) § Summary