FT 5105 Food Microbiology

Instructors

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Course Description

- No. of units: 02
- Mode of delivery: Lectures (30 h) and practical (04h)

Day, Time & Venue

- Day: Saturday
- Time: 4.00-6.00 p.m.
- Venue : Auditorium, PGIA - old Building

Assessment Strategy

Component	Percentage
• Mid term examination	40
• Quizzes	10
• End term examination	40
• Assignment on practical	10

Course Content

- Introduction - TM
- Major groups of microorganisms in food & primary sources - TM
- Factors affecting their growth – TM
- Microbiology of different foods - TM
- Spoilage microorganisms & Food Spoilage - TM
- Fermentation, Fermented Foods – TM
- Food borne diseases - NR
- Detection and enumeration of microorganisms – NR
- Indices of sanitary quality and microbial standards - NR
- Molecular biology or microorganisms in food – NR

TM – Terrence Madhujith; **NR** – Niranjan Rajapakshe

INTRODUCTION

Lesson Aims

To introduce

- the importance of Food Microbiology
- Different applications of Food Microbiology

INTRODUCION

- Food safety is one of the biggest concern
- Food- borne diseases are reported almost daily
- Food-borne diseases sicken many people and affect the health and well being and productivity of a population
- Expenditure on healthcare

Common Food-borne Outbreaks

- Common food-borne outbreaks
  - Salmonella
  - Shigella outbreaks
  - Cholera outbreaks
  - *E. coli* outbreaks
  - Listeria outbreaks

Food Spoilage

- Preservation of food is challenged by microorganisms
- Heavy losses of food in the world due to microbial action
- By controlling the factors necessary for their growth it is possible to control their growth and reproduction and thereby control spoilage

Beneficial Microorganisms

- Some microorganisms are beneficial
- Fermentation helps preserving and fabricating foods
- From the standpoint of environment, spoilage of food is beneficial

Some Fermented Products

- Yoghurt, cheese, curd, pannier
- Alcoholic beverages: beer, wine
- Vinegar
- Fermented vegetables
- Tofu
- Fermented cereals
- Vitamins, Antibiotics, Amino acids Hormones

Knowledge on microorganisms becomes helpful

- Food preservation
- Food processing
- To achieve high production
- To achieve high quality
- To develop new foods
- In functional food industry
- Novel uses

Highlights in Microbiology

- 1674 – van Leeuwenhock discovered MO
- 1796 – Jenner made a vaccine for smallpox
- 1859 – Pasteur disproved the theory of spontaneous generation of mo
- 1865 – Lister introduced antiseptic techniques
- 1876 – Koch proved that specific mo cause specific diseases
- 1892 – Iwanowski discovered viruses

- 1929 – Fleming discoverd penicillin
- 1977 – smallpox was eradicated from world
- 1982 – Stanely Prusiner presented evidence that prions causes neurological disorder in animal and human
- 1983 – Luc Montaigner and Robert Gallo discover HIV, the cause of AIDS
- 1995 – Sequence of bacterial genome is completed by Craig Venter and colleagues

Historical Developments in Food Microbiology

- 1782 – canning of vinegar is introduced by a Swedish chemist
- 1810 – food canning is patented by Appert in France
- 1813 – use of sulfur dioxide for preservation
- 1835 – patent for canning condensed milk
- 1855 – powdered milk is introduced by Grimwade
- 1880 – pasteurization of milk is introduced in Germany
- 1928 – First commercial use of controlled atmospheric storage for apples

Subgroups

- MOs are divided into six subgroups
  - Bacteria
  - Archaea
  - algae
  - Fungi
  - Protozoa
  - viruses
- These subgroups are not closely related to each other
- The main similarity is the size

Cell Structure

- Mos are divided into two subgroups again based on cellular structure
  - Prokaryotics
  - Eukaryotics

Characteristics of microbial subgroups

Subgroup	Cell type	macroscopic	photosynthetic
Bacteria	prokaryote	no	Yes
Archaea	prokaryote	No	Yes
Algae	eukaryote	Yes	All are
Fungi	eukaryote	Yes	No
protozoa	eukaryote	No	No
viruses	Acellular	No	no

Bacteria

- Very small in size
- Mostly unicellular
- Very diverse
- Different shapes
  - Rod
  - Spherical
  - Helical
  - Comma

star shaped

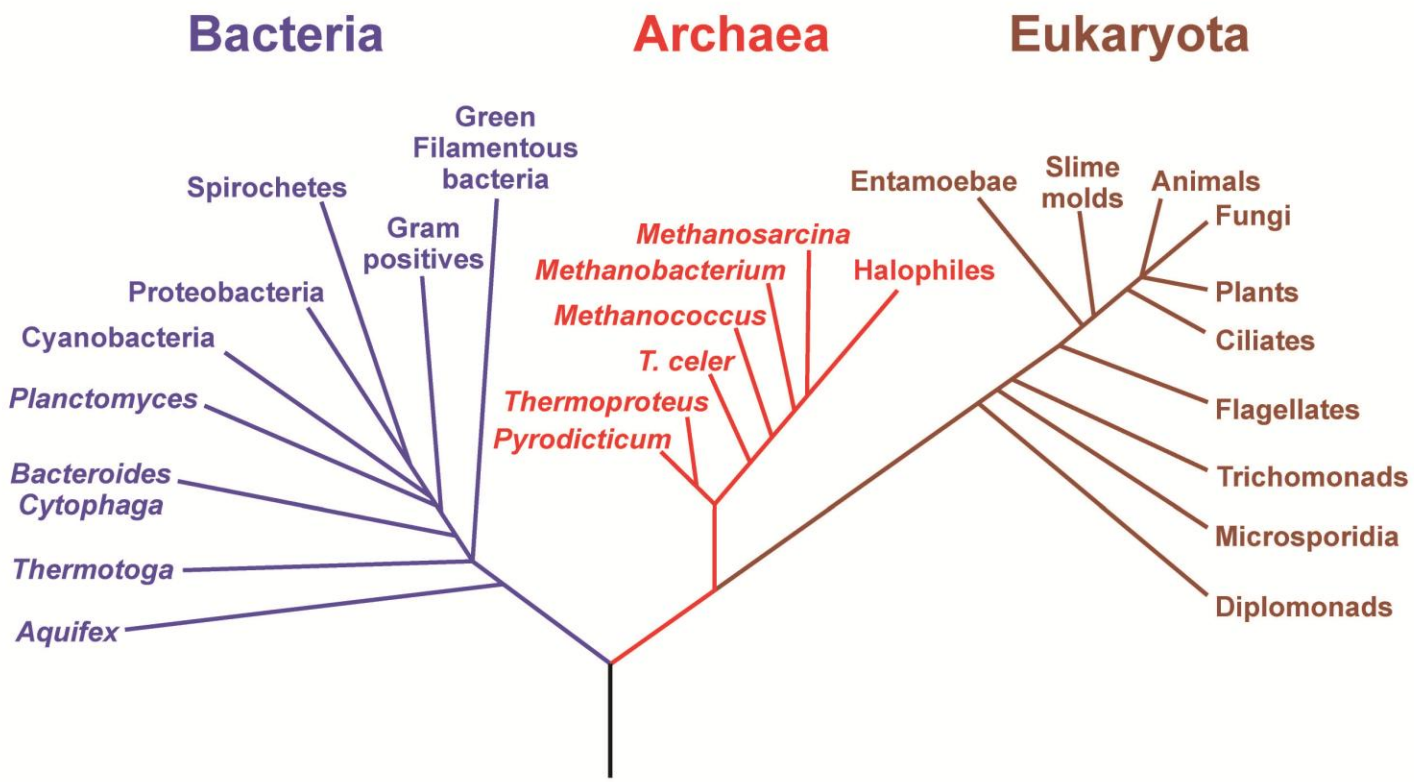
square

- Some can grow at -20 ^{o}C while some others can grow at 110 ^{o}C
- Some use organic matter while others can utilize inorganic materials
- Some are photosynthetic
- Some can live acidic conditons while some others can live in alkaline solutions

Archaea

- Separated only in 1970 from bacteria
- Considered to be ancient bacteria type
- First they were called archaebacteria
- They are very different from bacteria although they look like bacteria
- Largely extremophiles
- Some produce methane
- *Methanobrevibacter smithii*

Phylogenetic Tree of Life



Algae

- Eukaryotes
- Carry out photosynthesis
- Unicellular or multicellular
- Microscopic or macroscopic
- Large algae look like plants but lack stems, roots or leaves

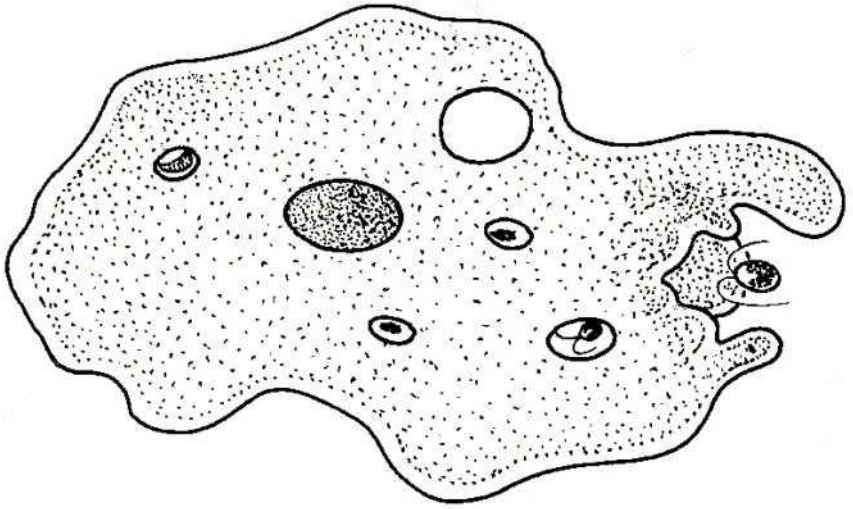
Fungi

- Include mushroom, yeast and mold
- In food microbiology yeasts and molds are considered separately
- Most are scavengers, thus ecologically important
- Some are pathogenic to humans and animals
- E.g. *Pneumocystis carinii*

- Most fungi grow as multibranched tubes making up mycelia
- Yeasts are unicellular
- Molds are generally multicellular
- Molds attack plants and cause plant diseases

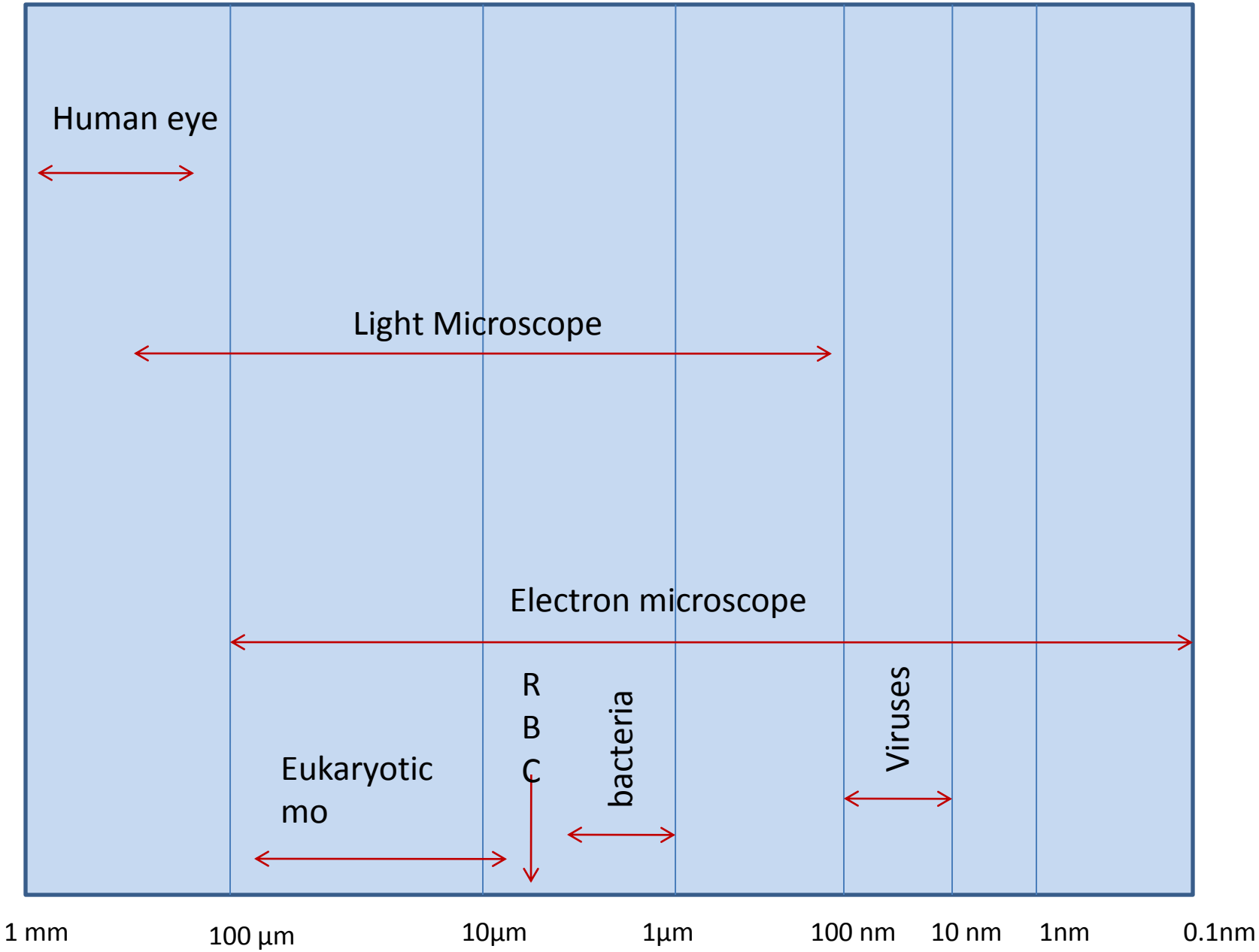
Protozoa

- Unicellular and motile
- E.g. amoeba
- Some cause diseases e.g. amoeba, African sleeping sickness and malaria



Viruses

- Acellular
- DNA or RNA particles packed in protein coats
- Sometimes bear a membrane surrounding the coat
- Incapable of reproducing on their own
- Can reproduce only in host cells
- Extremely small
- Largest virus is less than 1/10 of bacterial cell


Human eye
Light Microscope
Electron microscope
R
B
C
bacteria
Viruses
Eukaryotic
mo
1 mm
100 µm
10µm
1µm
100 nm
10 nm
1nm
0.1nm

Use of Microscopy

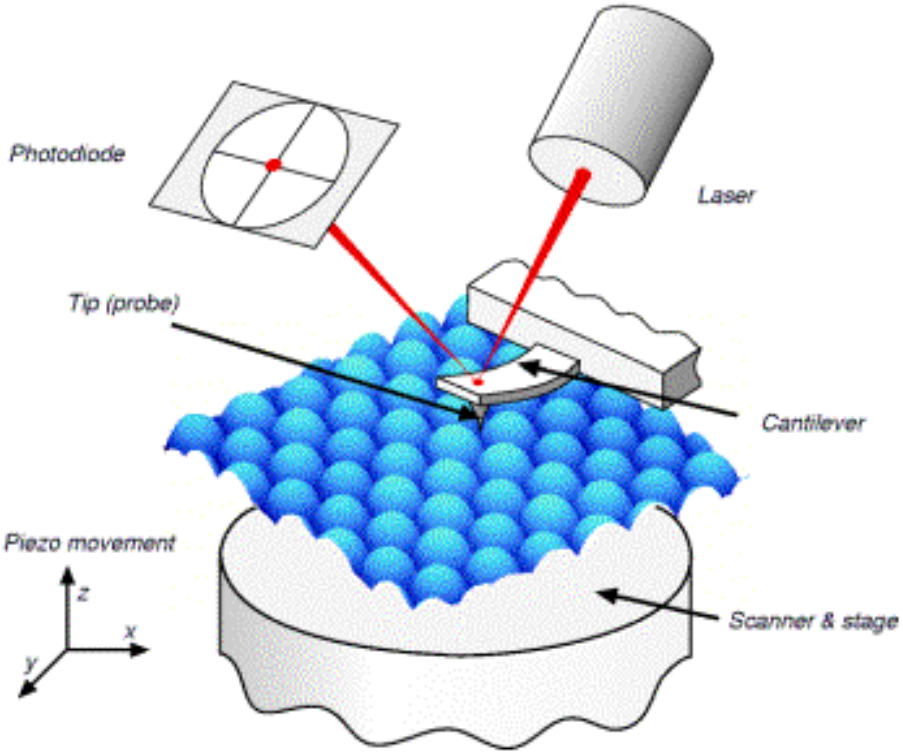
- Different types of microscopes are in use for examining MOs

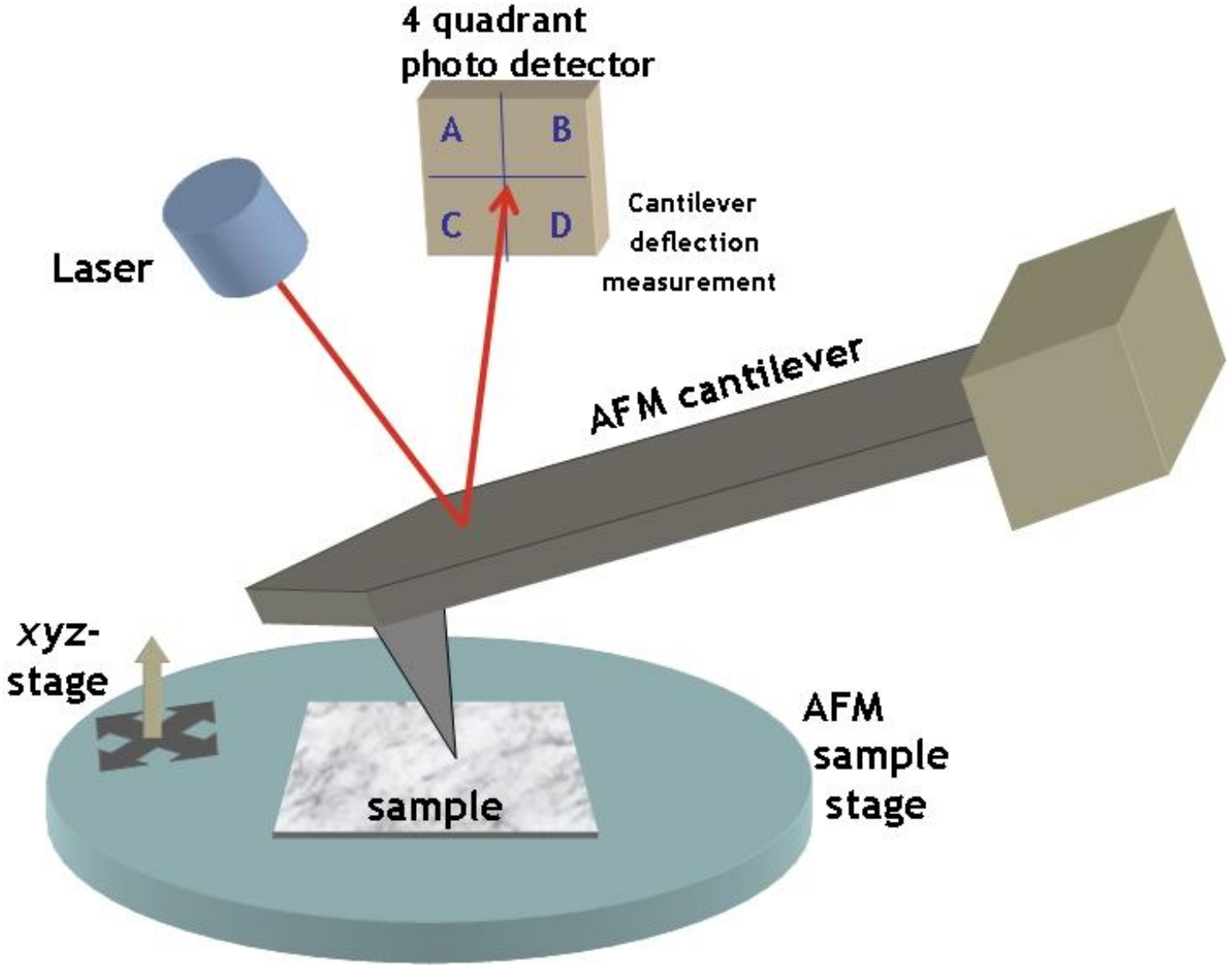
  Light microscopy

  – Brightfield - contrast achieved by absorption
  – Darkfield – brilliantly lit against a dark background
  – Phase contrast – contrast achieved by interference
  – Fluorescence – colored against a dark background
  – Confocal – produces 3D images by computer manipulations

- Electron microscopy
  - Scanning
  - Scanned proximity
  - Scanning tunneling
  - Transmission

- Atomic force


Photodiode
Laser
Tip (probe)
Cantilever
Piezo movement
z
x
y
Scanner & stage


4 quadrant
photo detector
A
B
C
D
Cantilever
deflection
measurement
Laser
AFM cantilever
xyz-
stage
AFM
sample
stage
sample

MAJOR MICROORGANISMS IN FOOD
LECTURE - 02

Lesson Aims

- To introduce different microorganisms (both beneficial and harmful) present in association with food

Bacteria

- *Acinetobactor*
- *Aeromonas*
- *Alcaligenes*
- *Altermonas*
- *Enterbactor*
- *Erwinia*
- *Escherichia*
- *Flavobacterium*

- *Pediococcus*
- *Proteus*
- *Pseudomonas*
- *Psychrobactor*
- *Bacillus*
- *Brochothrix*
- *Campylobactor*
- *Carnobacterium*
- *Citrobactor*
- *Corynebacterium*
- *Clostridium*
- *Enterococcus*
- *Lactococcus*
- *Lactobacillus*
- *Leuconostoc*
- *Listeria*
- *Micrococcus*
- *Moraxella*
- *Salmonella*
- *Serratia*

- *Shigella*
- *Vagococcus*
- *Vibrio*
- *Yerisinia*

Molds

- *Alternaria*
- *Botrytis*
- *Colletotrichum*
- *Geotrichum*
- *Mucor*
- *Rhizopus*
- *Wallemia*
- *Apergillus*
- *Cladosporium*
- *Fusarium*
- *Monilia*
- *Penicillium*
- *Trichothecium*
- *Xeromyces*

Yeasts

- *Brettanomyces*
- *Schizosaccharomyces*
- *Rhodotorula*
- *Torulaspora*
- *Cryptococcus*
- *Hanseniaspora*
- *Issatchenkia*
- *Pichia*
- *Saccharomyces*
- *Kluyveromyces*
- *Debaryomyces*
- *Zygosaccharomyces*

Protozoa

- *Cryptosporidium parvum*
- *Giardia lamblia*
- *Toxoplasma gondii*
- *Entamoeba histolytica*

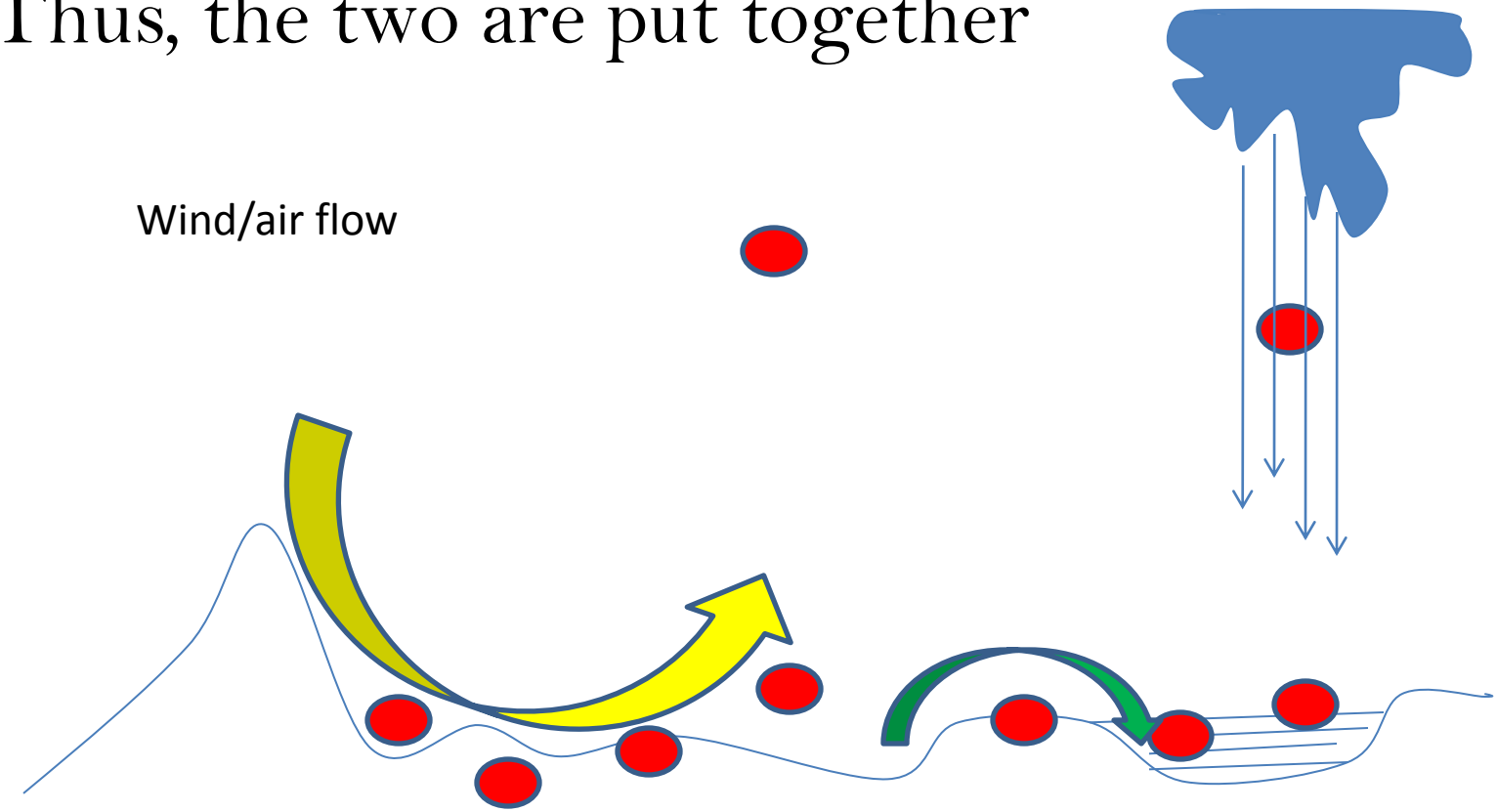
Primary Sources of MOs Associated with Food

- Each genus has its own nutritional and environmental requirements
- Eight different sources are identified
- 1. Soil and water
- 2. plants and plant products
- 3. Food utensils
- 4. GI tract
- 5. Food handlers
- 6. animal feed

- 7. Animal hide
- 8. Air and dust particles

1. Soil and water

- Many Mos share these two environments
- Thus, the two are put together



- Though many share the two environments there are some that can not share
- E.g. Altermonas spp need sea water salinity for growth and development thus they are not present in soil
- Seawater bacterial flora is essentially gram negative
- G(+)ves can present only as transients

2. Plant and Plant Products

- Many soil and water Mos get in touch with plants but only a few can live in plants.
- They are basically plant pathogens. e.g. Pseudomonas, Xanthomonas, Corynebacterium etc. and some molds.
- Others can not stay adhered to plant surface or impose pathogenicity in plants
- They are easily washed off to the ground and water.

3. Food Utensils

- Type of flora depends on the type of raw materials handled.
- E.g. the composition of flora in utensils handling fruits and vegetables is different from the utensils used for meat or fish

4. Gastro Intestinal Tract

- GI tract provides an ideal environment for some Mos
- Many pathogenic bacteria and all 4 protozoa live in GI tract
- Citrobactor, enterococcus, salmonella, Escherichia, Hafnia, Shigella and Vagococcus

5. Food handlers

- Depends on the environment and habits
- Chronic carriers
- Mos from nasal cavities, cuts, boils, bruises, open wounds etc.

6. Animal Feed

- An important source
- Spread onto animal hide
- Can cause diseases
- E.g. Salmonella in poultry
- Listeria monocytegenes from silage

7. Air and Dust

- E.g. gram positive bacteria in the air in food processing environments

8. Animal Hide

- A rich source of Mos.
- MOS residing in hide can easily get into animal products such as milk, meat