Micro

①

The Science of Microbiology

7-16-04

Chapter 1

Microbiology: is the study of microorganisms (sometimes called microbes).

Microbes: living things that are ~~too~~ small to be seen by the unaided eye.

Inspite of their tiny size → have enormous impact

1) They maintain our environment in life-sustained balance
2) Most industrial tools
3) Uncheckeed → can destroy our livestock and crops.
4) Spoil our foods
5) Make us sick and even kill us.

Pathogenic: Disease-causing microbes often controlled human events.

With the epidemics they caused came:
- social and political change
- chaos
- untold human suffering

bacteria → yersinia pestis → y. pestis

Examples

The bubonic Plague: called plague or black death.

swept through Europe during the middle ages
- killed ~25 million people ~1/3 of the population
- Resulting terror was intense because the cause of the disease was unknown
- 500 years later, in 1890 microbiologists identified the causative organism as a bacteria

The Irish Famine:

Potato blight, a disease of plants rather than humans → caused by a fungus

- In 1800, → caused the great Irish famine
  Potatoes were the staple of the Irish diet
  so, fungus → infected → Potatoes →
  causing them to rote in the fields
  → results was devastating.
  → Starvation & hunger — based
  disease were & widespread
  → 1.2 million died, 1.2 million immigrated

The Cholera: Yellow air:

1800s, swept Egypt, killed > 70% of population
caused by a bacteria, scientist who discovered
it was killed by the bacteria

Disease of Warfare:

In 1812 Napoleon invaded Russia → lost
more of his troops to typhus (a bacterial
disease) than to all other causes combined

Microbes and life Today:

Pathogenic microorganisms are still responsible for
a vast spectrum of human diseases and suffering

- Advances in medical microbiology made it possible to:
  a) identify the various pathogens that cause
  infectious disease
  b) devise ways to control most of them
  c) developed vaccines to prevent infections
  d) " drugs to treat them

Preventing infectious disease:

- Public hygience such as
  a) water treatment
  b) sewage treatment
  c) better living conditions

Still can not completely control microbial disease:

- have many effective vaccines, but inoculating every child is not yet possible
- still lack effective vaccines for the most devastating infectious diseases
  a) acquired immunodeficiency syndrome: AIDS
  b) Malaria
  c) lost their effectiveness e.g: tuberculosis, e.g: drug resistant bacteria →
     need to replace those and find new drugs. If resistant bacteria can not be treated, devastating infectious disease can come back.

Small Percentage of microorganisms are pathogens.

- microbiology has discovered ways to use these other microorganisms to improve the quality of our lives.

applied microbiology:

- environmental
- industrial
- agricultural.

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The Scope of Microbiology

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Microbes and life Today:

Microbes → Advances have occured in:

① Environmental Microbiology; called also microbial ecology: The study of how microorganisms affect the earth and its atmosphere.

a- microbes maintain our life-supporting environment

b- Break down and eliminate the mounting toxic waste we produce.

② Industrial Microbiology: Human use of Microbiology:

To make and preserve food:

use microorganisms to make

Bread, wine, vinegar, cheese and others

Some industrial uses of microorganisms:

- cheese: growth of microorganisms contributes to ripening and flavor of a particular cheese.
- Alcoholic beverages:

Yeast is used to convert

Sugar, grape juice ⟶ alcohol

- Vinegar:

Bacteria are used to

alcohol ⟶ acetic acid (vinegar)

- Citric acid:

Certain bacteria are used to make citric acid, a common ingredient in soft drinks

- Vitamins: microorganisms are used to make vit e, B_2 & B_{12}
- Antibiotics: Most antibiotics are made by microorganisms
- Human growth hormone and insulin and other useful proteins ⟶ are made by genetically engineered bacteria by placing human gene in bacteria

→ bacteria is grown in liquid Culture to express these proteins
→ then purify insulin & growth hormone
→ treatment of human.

③ Agricultural Microorganism:

- livestock & crop plants are now largely protected from microbial disease
- microorganisms that kill insects are used as natural pesticides.
- used to maintain soil fertility.

Careers in Microbiology:

Depends on training and interest
- Research to find new a) microorganisms
b) new microbial activities
c) new relationships among microorganisms.

Merging resistant bacteria to available antibiotics is a growing concern and challange to new micr. careers in microbiology.

The scope of microbiology:

Microorganisms are divided into 6 subgroups

Subgroups of microorganisms; General Properties

	Subgroup	Cell type	photosynthetic	Motile	Macroscopic
1-	Bacteria	Prokaryotic	Yes	Yes	NO
2-	Archaea	"	"	"	"
3-	Algae	Eukaryotic	All are	Yes	Yes
4-	Fungi	"	NO	NO	Yes
5-	protozoa	"	NO	Yes	NO

6- Viruses Acellular NO NO NO

Bacteria

Sing: Bacterium

Bacterial cell has about one-thousandth (0.001) the volume of a typical eukaryotic cell.

- Bacteria are diverse:

e.g: a) cell shape:

spherical, rod-spherical, helical, comma-shaped, star shapedy or even square.

- oxygen concentration: 1) some bacteria are motile others are not motile

Aaerobe: grow in the presence of O2

Anaerob: grow in its absence

Facultative anaeroby: do not require O2, but grow better in it

obligate anaerobes: Do not tolerat O2 ↓ die in its presence.

c) obtain energy by
1- from organic compound (food), as animal
2- light energy as plants do
3- inorganic materials, e.g: sulfur, iron for energy.

d) Grow at temperatures:
1- as low as -20°C
2- at 110°C

e) Some grow best under acidic others thrive in environment mor alkaline

f) Cause a vast spectrum of diseases:
1) Food poisoning
2) syphilis
3) typhoid fever

But they also make plant at human and animals existence possible → by keeping earths environment and

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Archaea:

First discovered in the 1970s and called archaebacteria (ancient bacteria).

- but they are distantly related to bacteria as they are to eukaryotes, therefore their name has been changed.
- They live in hostile environments - that would be deadly to most living things. Examples
  - Extremely hot or acidic or that contain high concentration of salt.
- One major group of archaea makes → Methane (Natural Gas)
  → produce the gass that bubbles up from many quiet ponds.
- No archaea are human pathogens.

Algae:

- are eukaryotic organisms — carry out plantlike photosynthesis.
- have chloroplasts: the structure in which photosynthesis takes place.

Algae are:

← example euglena

- Unicellular and microscopic: Example phytoplankton,
- Multicellular and macroscopic (visible without the aid of a microscope).

Example: - Kelp: the large brown seaweed that washes up on Pacific ocean beaches

- green algae grow on some tree stems

Multicellular algae may look superficially like higher plants, but they lack characteristic plant organs including:

stems, roots, and leaves.

Fungi:

Include organisms we call:

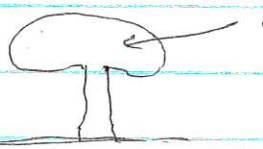
- mushrooms: formed from underground mycelium (multi branched tubes)
- yeasts: are unicellular fungi
- Molds: primitive fungi, infects plants

They are - eukaryotic
- non-photosynthetic
- Most fungi are scavengers

~~Two kinds~~:

a) Microscopic: e.g: of microscopic fungus is a) Epidermophyton floccosum: is one of many associated with athete's foot

b) Macroscopic fungus: e.g: the mushroom Amanita muscaria, which causes hallucinations if eaten



b) others cause life-threatining infections: e.g: is Pneumocystis: Pneumocystic carinii, which invades the lungs of immunologically weakened individuals, such as AIDS patients ⟶ Causing Pneumocystic Pneumonia

c) Many fungi are pathogenic to Plants e.g: potato blight, wheat rust, corn smut.

Protozoa:

Protozoa means first animals, are superficially animal-like.

- are nonphotosynthetic
- " usually motile

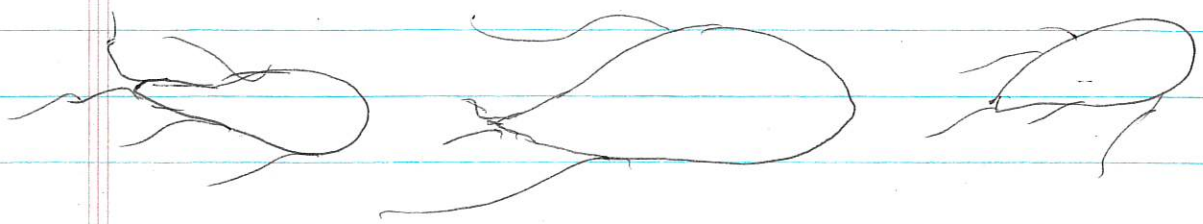
Examples:

- Amoebae: class of protozoa that move by extending tubelike structure called pseudopods
- other classes that moves by
  a) flagella: called Flagellates (long)
  b) short: cilia — hairlike extensions that wave or beat.

Paramecium

Protozoa cause diseases.

1) The protozoan Giardia lamblia is a common cause of diarrhea in humans



2) Malaria 3) African sleeping sickness that kill millions of people every year.

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Viruses:

Viruses are not cells

- are merely particles of nucleic acids, either RNA or DNA, packaged in a protein coat, and sometimes surrounded by a membrane
- are incapable of reproducing themselves, they can reproduce only inside a host cells.
- Infect animals, plants, and other microorganisms.
- Are extremely small: The largest viruses are about one ~~thousandth~~ tenth 1/10 the size of a typical bacteria, the smallest are 1/1000

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Prions:

are simpler infections agens, chemically and structurally simple as viruses.

- they are composed exclusively of protein.
- Remains unknown, how they reproduce.
- Prions cause rare a) Neurological disease in humans
  b) mad cow disease in cattle
  c) scrapie in sheep

Helminths:

are worms → belong to the animal kingdom, we study them in microbiology because they cause infectious diseases.

two types:

a) flatworms b) roundworms

Flatworms: include the beef tapeworm, can grow to length of 30 feet in human intestine.

Eggs in human feces → grass → cow eating → egg hatch in beef intestine → blood circulation → reach flesh and make a small cyst → human eat uncooked beef meat → cyst → grow in human intestine to become again flatworm.

b) Roundworms: eg:

Trichinella, which humans acquire from eating contaminated pork

Trichinella causes → Trichinellosis a severe human disease

Microbiology today:

4- Key areas

1) Chemotherapy: treatment of disease with chemicals called drugs. Now, people use it for Cancer treatment

In 1894:

Paul Ehrlich a German physician-chemist articulated the → Selective toxicity:

For a drug to be effective against infection, it must be selectively toxic →

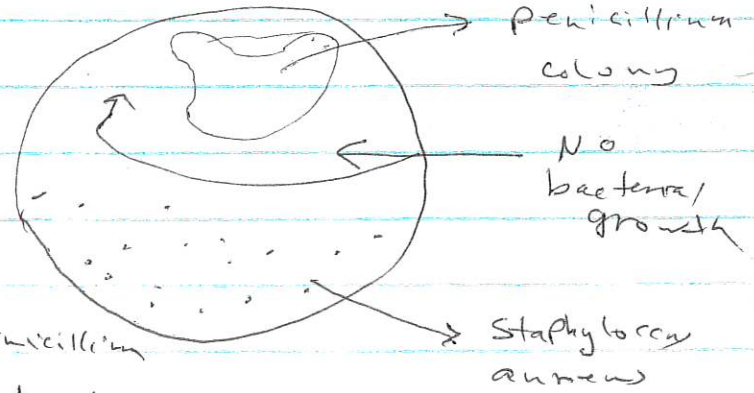
strike and kill the microbe but not the host " called it magic bullets"

- Ehrlich in 1908 → discovered a drug for the treatment of syphilis; called it Salvarsan.
- 1930: Sulfa drug: synthetic drugs were discovered to treat bacterial infection it was so expensive that only rich can afford to buy it.
- Antibiotics:

Chemotherapeutic agents produced by microorganisms

- In 1929: Alexander Fleming: Italian microbiologist working in UK " called as Scottish" discovered Penicillin.

S. aureus was being cultivated, accidentally became contaminated by a fungal spore → developed → colony of Penicillium → area around it killed bacteria



→ 1940s : during world-war II penicillin became really available, before, technical problems in purifying and mass-producing it made it not widespread for clinical use.

② Immunology

Immunology was a branch of microbiology devoted to developing vaccins for preventing infections diseases, Today:

→ independent and fast-developing science.

immune system is extremely complicated, delicate and prone to defects.

③ Virology :

The study of viruses

1892 : TMV : tobacco mosaic virus was discovered

1930s : the electron microscope was developed, we knew viruses existed, but little more

→ as called disease-causing agents were passing through the filters, called ting agents " filterable viruses".

④ Genetic Engineering and Genomics :

Studies on microorganisms → have led to the development of genetic engineering = r DNA technology.

Example: industry uses Escherichia Coli (E. Coli) to produce human insulin → treat diabetes.

Human gene → isolated → cloned in a plasmid

introduced ← into E. Coli

grow in liquid culture ← purify

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The Methods of Microbiology:

Viewing Microorganisms

Measuring microorganisms:

Microbiology uses the metric system of measurement:

m = Meter = is the basic unit of length

l = liter = " " " " Volume

g = gram = " " " " weight

Examples:

1 meter = 100 cm 1 μm = 1000 mM

1 cm = 10 mm 1 mM = 1000 nm

1 gram = 1000 mg

1 mg = 1000 μg micro

1 μg = 1000 ng nano

1 ng = 1000 pg pico

1 liter = 1000 ml

1 ml = 1000 μL

1 dL = 100 ml Deci (dL)

Human RBC = 12 μm

Typical bacteria = 1–5 μm

Virus = 10–100 nm

atom = 0.1 nm

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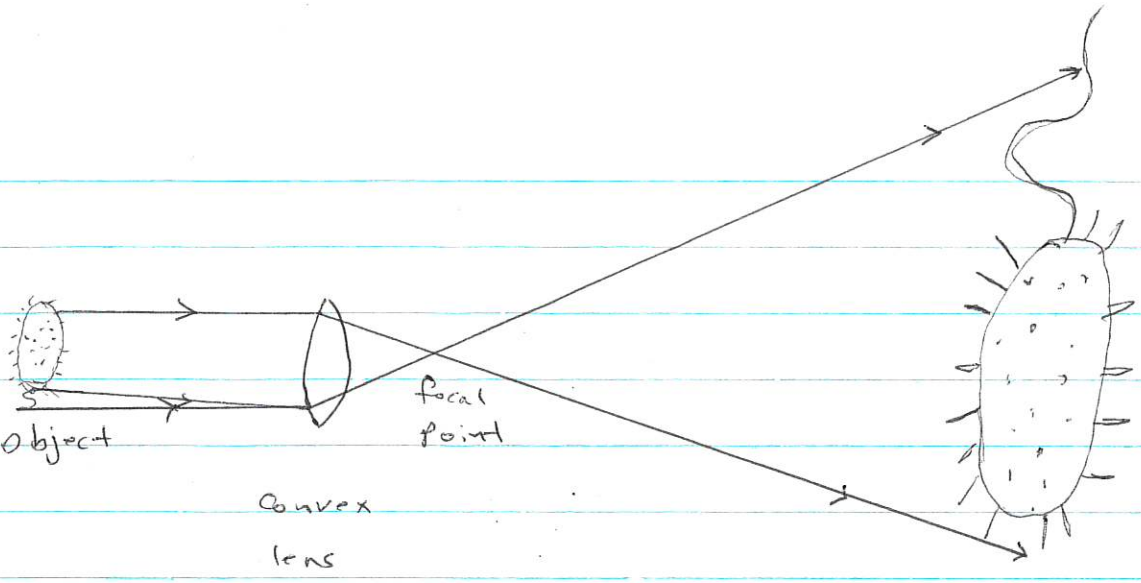
Microscopy:

Magnification: we use a microscope to achieve magnification (enlargement of the image). Any convex lens (thicker in the center than at the edge) can magnify. By refraction it forms an enlarged image of the object behind it.

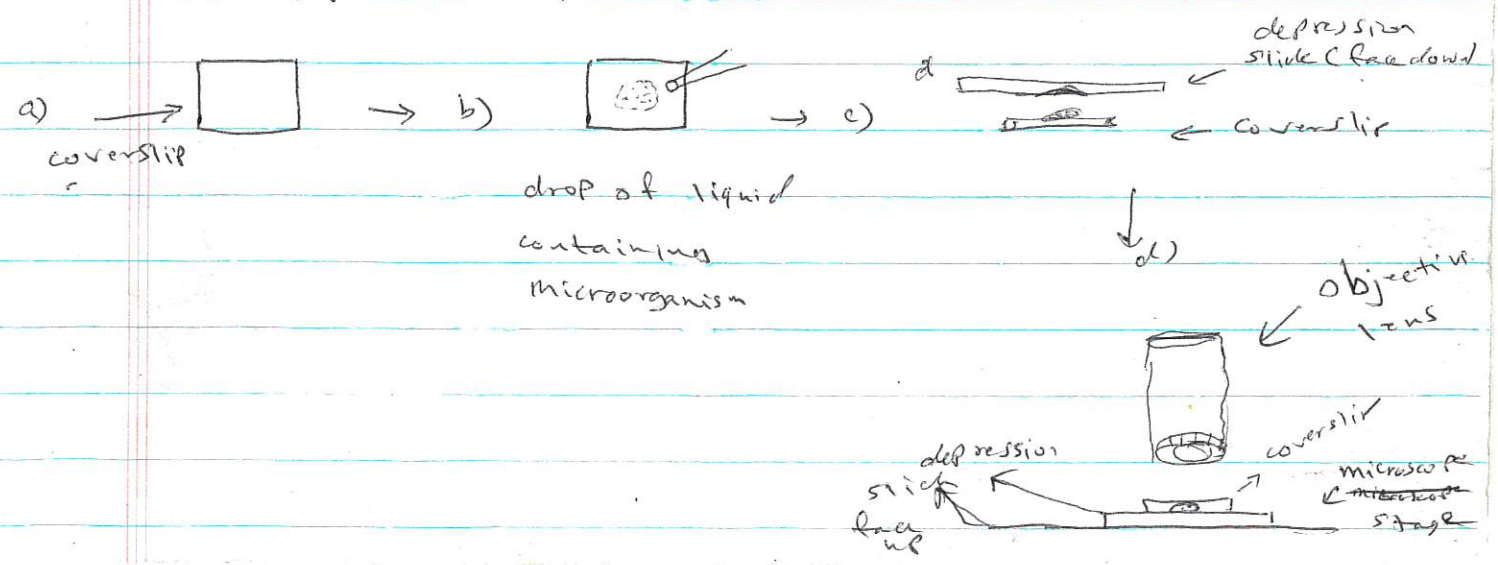


Total Magnification:

Microscope	objective lense	total magnification
- light microscopes		
Lower power	10 X	100 X
High power	40 X	400 X
Oil immersion	100 X	1000 X
- Electron microscopes		
Transmission (TEM)		- 200,000X

Wet Mounts:

A wet mount is the simplest way to prepare a specimen for microscopic examination



Wet mounts are used to observe living microorganisms.

Example:

To examine vaginal secretion for Trichomonas vaginalis a highly motile protozoon → causes inflammation of the vagina and urethra.

→ if the specimen contains fish-shaped cells that move jerkily across the field → (+) ve

→ Many microorganisms lack sufficient contrast to be clearly visible in a wet mount

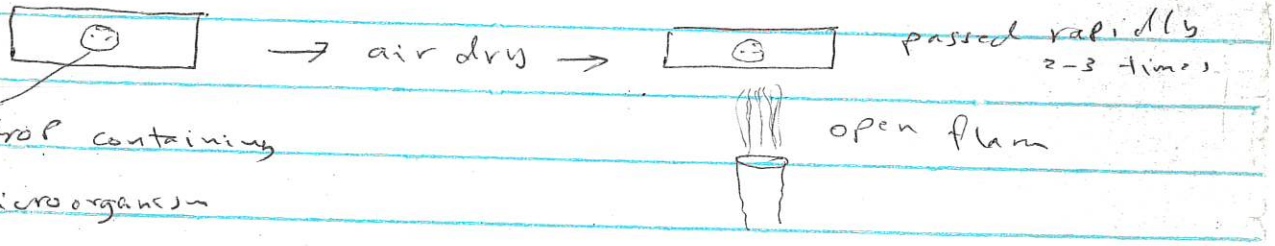
→ To visualize them → necessary to use staining.

Staining:

Stains are dyes that increase contrast by binding selectively to certain cells or certain part of cell component.

First step: Fixation: microorganisms are killed and attached to a microscopic slide).

a) Heat fixation: is the usual method



Heat kills cells by denaturing their protein, which sticks the cells to the slide

b) Chemical fixation: does less damage than heat

c) Osmic acid, formaldehyde, or glutaraldehyde is most often used.

Fixation brings difficulties:

1- Distors cells appearance 2- motility no longer be studied.

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Stains: "Continue"

are dyes that increase contrast by binding to Cells.

Types of dyes:

1- Basic dyes = have ⊕ ve charge
2- Acidic " = " ⊖ ve "

Examples

Basic dyes	Acidic dyes
Safranin	Eosin
Basic fuchsin	Acid fuchsin
Crystal Violet	Congo red
Methylene blue	

fyik sam

3- classes of staining procedure:

1- Simple stains:

are basic dyes → cell visible with Same color (cells absorb dye).

2- Differential stains:

To distinguish between types of microorganisms. — at least 3-steps

a- primary staining b- destaining — c) counterstaining (application of another dye to reveal the cells).

The Gram Stain:

- Developed by the Danish bacteriologist: christian Gram in 1884. It divides bacteria into two groups:
1) Gram-positives 2) Gram-negatives

Step 1: primary stain: Gentain Violet: made from: crystal violet, alcohol, ammonium chloride and water

Step 2 : Mordant : intensify staining by increasing a cell's affinity for a dye.

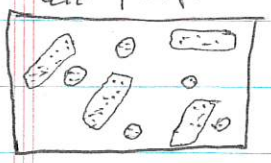
Iodine is applied → set the stain

Step 3. Decolorization :

usually alchol or acetone-alcohol. is added, Gram positive bacteria retain color.

Step 4 Counterstaining

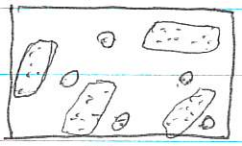
: The red stain (dye) : Safranin is added.



Step 1 :

Crystal Violet (1 minute)

drain and rinse



Step 2 :

Iodine (mordant) added (1 minute)

drain and rinse

Gram ⊕ve = purple

Gram ⊖ve = clear

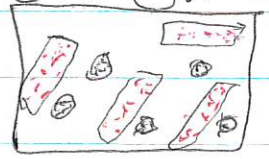
Step 3 :

Decolorize with acetone-alcohol

Come quick rinse, immediately after, rinse with water

Gram ⊕ve = purple

Gram ⊖ve = red (pink)



Step 4

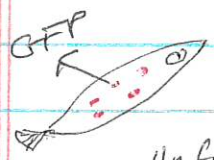
Safranin : 30-60 seconds

drain, rinse, and blot

Molecular stains: A new use for Jellyfish:

recombinant DNA = rDNA technology made it possible to combine genes and thereby attach a foreign protein to one of a cell's own protein. Called reporter protein

Example:



GFP → Gene isolation → Cloned

Jellyfish = aequorea Victoria

GFP gene → attached to a particular gene in any cell needed to be studied

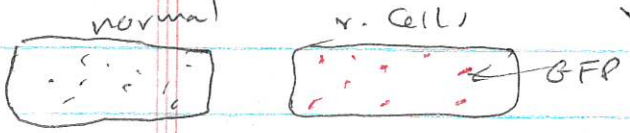
↓ recombinant (contains plasmid) cells are grown

Cells express r. protein (containing GFP)

↓ illumination with blue light (uv)

↓ GFP fluoresces light at 475 nm

↓ r. protein appear green in a cell



GFP: has become an extremely valuable research tool; microbes tagged with GFP can be easily detected in a mass of other microbes or within the tissue of a host.

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Culturing Microorganisms:

- The small size and rapid growth of microorganisms makes them ideal experimental subjects.
- To do experiments → necessary → to culture (cultivate)

Pure Culture:

Pure culture → consisting of a single type microorganism derived from a single cell.

inoculation
incubation
isolation
identification

two steps

① Materials are sterilized to eliminate all microorganisms present

② One single microbial cell is isolated and cultivated to produced a clone → descendant of a single cell.

Sterilization:

All apparatus and materials used to obtain a pure culture must be sterilized. that includes,

- Media, e.g: liquid or solid media, flasks, test tubes, dishes, pipettes, inoculating needles, test tube caps, etc.

Methods:

a) Heat Sterilization:

i) Moist heat: means exposed to steam and it is more effective. T = 121°C (250°F) for 20-30 min. sterilizes most laboratory materials.

Autoclave: A pressurized container designed to sterilize materials (resembles a large version of an ordinary home pressure cooker)

B) Dry Heat: Heating in an oven or exposure to a flame an open flame is used to sterilize:

- flask or test tube opened to add or remove materials → the neck is passed through an open flame to kill any microorganisms that might have landed there
- Empty glass pipetts
- The wire inoculating loops used to pick up microorganisms from one surface and move them to another.

4) Filtration:

Microbial cells can be removed from liquid or gases by filtration, it is more time-consuming and expensive (a new filter must be used each time) than autoclaving.

- Only heat-sensitive liquids or solutions are filtered
- Filtration does not remove most viruses (10–100 nm or 0.1 μm), bacteria 1–5 μm
- Filters are membranes or sheets of porous nitrocellulose ~ approx. 0.45 μm in diameter,

e.g.: Solution containing vitamins, antibiotics, sugar (glucose,) and other heat-sensitive comp'ds Rubidium chloride,

chemicals:

One chemical used for sterilization: sodium hypochlorite (household bleach) — NaClO vs Cl_2

Commonly sterilize cultures after experiments are completed. 10% chlorox, 0.2% SDS works,

→ mix, leave overnight to assure all cells are killed before pour into sink.

- Sodium hypochlorite quickly kills most microorganisms.
  → sterilize the surface, benches, etc.

Isolation:

with all the sterile media and equipment we need now we can go on to isolate a pure culture:

1) separate a single cell from all others
2) provide it with the nutrients and environment it needs to grow.

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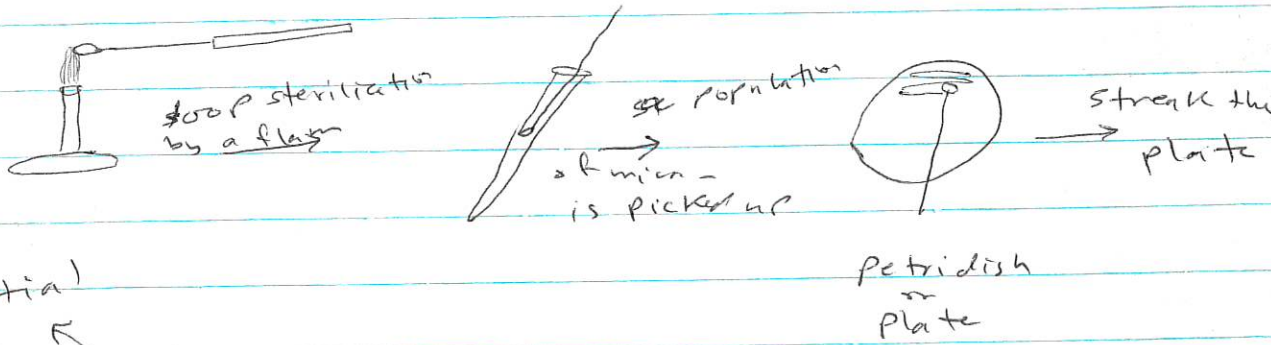
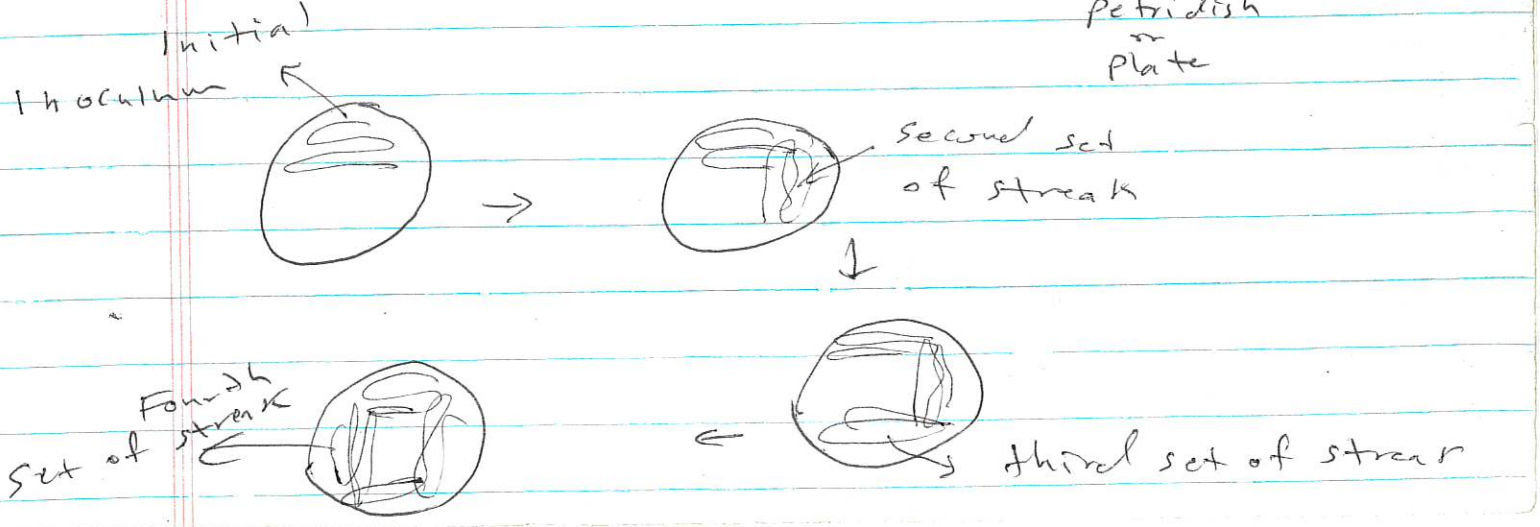
The streak plate Method: (Pure culture isolation—contin)

To isolate a single cell, dilution is usually done by streak plate, pour plate, or spread plate





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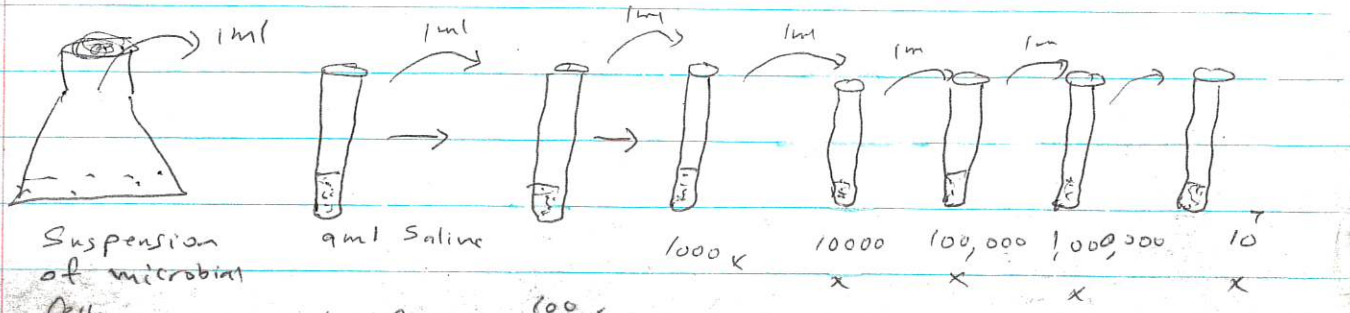
The plate method

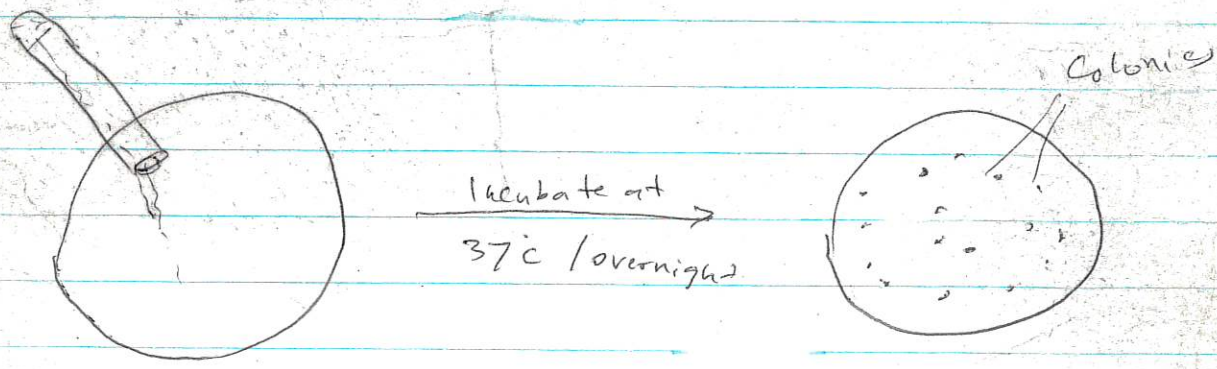
Dilutions are made before samples are put on the plate. Example

A suspension containing a billion 10^9 cells per ml.

We need about 100 (10^2) cells to put on a plate.

that means the suspension has to be diluted about ~~10 million~~ fold 10^7 : $\frac{10^9}{10^7} = 10^2 = 100$ cells





Growing a Pure Culture:

Medium can be

a) liquid b) solid

Media = prepared for microorganisms with known nutritional requirements:

- Organic source of carbon: e.g. glucose, Protein
- inorganic salt, e.g. NaCl

Two kinds of Media:

a) Minimal Media : carbon source + salts.

b) Complex Media : called a broth

— Ingradients of Nutrient broth:

a complex medium suitable for cultivating many species of bacteria

Ingredient	Amount	Comments
peptone (Tryptone)	10 g	Casein that has been Partially hydrolyzed by the enzyme trypsin
Yeast extract	5 g	Natural extract, large no. of compounds
NaCl	5 g	added to keep cell from clumping

in 1L

called Luria-Bertani : LB-Media or LB-Broth

LB-agar :

Tryptone = 10 g
Yeast extract = 5 g
NaCl = 10 g
Agar = 15 g

in 1L

Terrific Media (Broth):

Tryptone = 12 g
Yeast extract = 24 g
K_2HPO_4 = 12.5 g
KH_2PO_4 = 2.3 g / 1L

Selective-differential Media:

Some media are both selective and differential

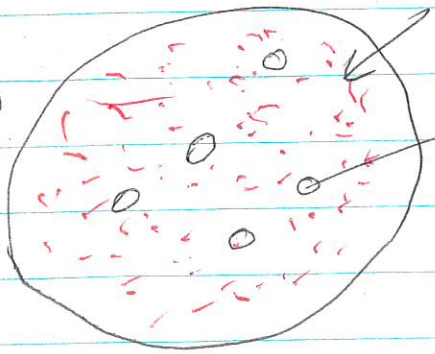
Example:

MacConkey agar Media:

→ used to detect strains of Salmonella and Shigella (intestinal bacteria that cause dysentery).

Selective: because it contains crystal violet and bile salts → inhibit the growth of many bacteria, but not Salmonella & Shigella

MacConkey agar



Providing a suitable growth environment:

a) Temperature: Best at 37°C

Cultures are kept at a constant temperature

b) optimal pH 6.5–7.5

c) Oxygen: liquid cultm must be aerated by shaking to mix oxygen into the culture.

i- shaking machines: platforms with holders for flasks, tubes.

2- Rotated or shaken continuously to mix oxygen into the culture.

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Prokaryotic and Eukaryotic Cells:

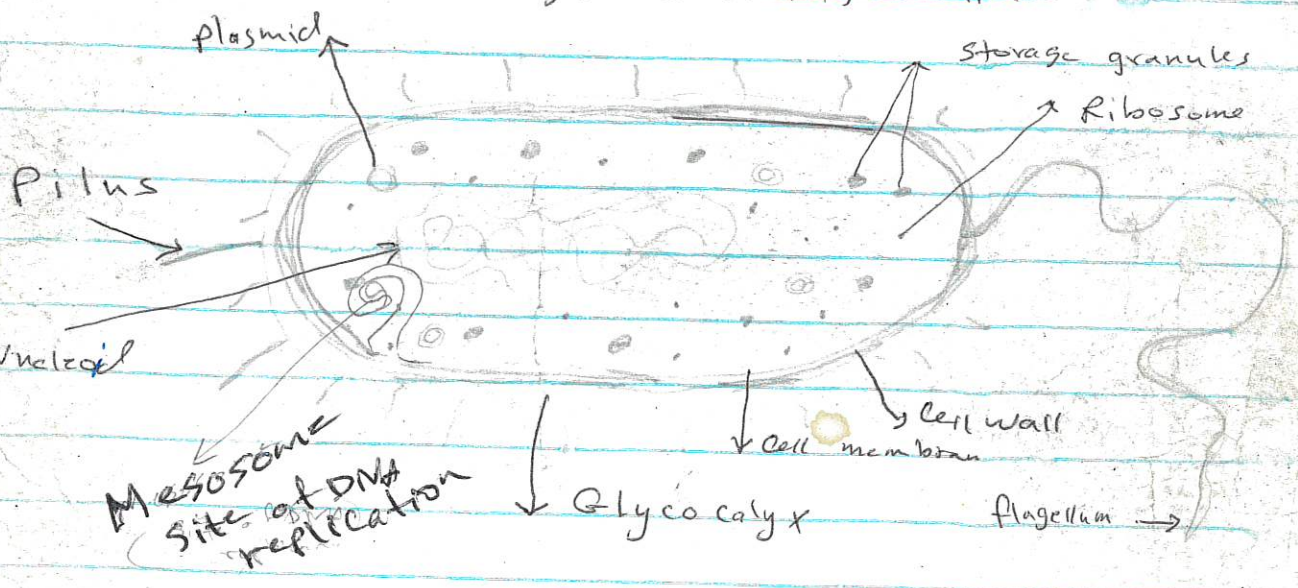
Structure and function:

- Cellular structure and function are always related
- Comparison of a bacterial cell and a human cell

	Bacterial cell	Human Cell	Comparison
Diameter	1 μm	10 μm	Bacteria is 10x smaller
Surface area	3.1 μm^2	1257 μm^2	" : 400x "
Volume	0.52 μm^2	4190 μm^2	" : 800x "
Surface/Volume ratio	6	0.3	" : 20x greater

The prokaryotic cell:

The structure of prokaryotic (bacterial) cell:



Prokaryotic cell:

Appendages: → Flagella : used for locomotion

← Pili : Sexual conjugation

Cell envelope: Glycocalyx = fibrinous network of cells within material that coat cells

Cell wall = 250 A°

Cell membrane = 70 A°

cytoplasm: cell pool

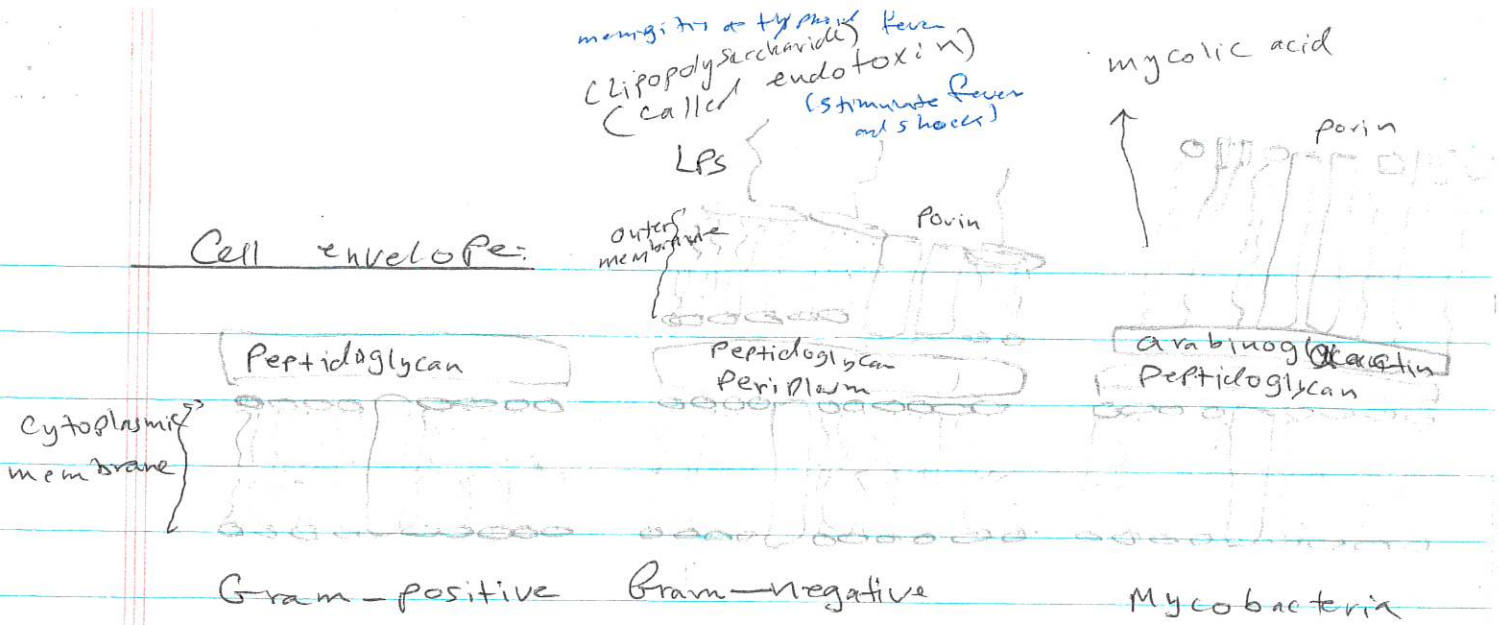
Ribosomes

Granules

Nucleoid / chromosome

plasmid

Cell envelope:



Mycobacteria (e.g. Mycobacterium tuberculosis) are protected from drugs by an outer barrier - that resembles the less-effective outer membrane of Gram-negative bacteria, which Gram-positive bacteria lack

- Only M. tuberculosis and related bacteria have mycolic acid:

→ unusual fatty acids → form Waxy layer around the M. tuberculosis, giving it some of its unusual properties: - slow growth rate

- acid-fast staining

- resistance to many antibacterial drugs and unique sensitive to others.

How can substances pass through the outer layer (the waxy layer) of mycolic acids?

- it's not just a disorganized waxy layer

a/ mycolic acid molecules are arranged into two layers ~ highly ordered membrane, the membrane surrounds the cell, but proteins are embedded

in the layer, forming water-filled pores through which nutrients and certain drugs pass slowly.

Cytoplasm:

- Composed of primarily water (90%).
- Most of cell's vital chemical reactions (Metabolism) take place in the cytoplasm.
- cytoplasm contains internal structures such as nucleoid, ribosomes, etc.

Prokaryotic = Pre-nucleus

Nucleoid or single chromosome:

- an irregular mass of DNA within the cytoplasm
- No surrounding membrane
- DNA is the code that directs all genetics and heredity of the cell.

Plasmids:

Many bacteria contain plasmids, its a circular DNA molecule,

- can be free in cytoplasm or integrated into the chromosome.

~~Function/importance~~

- other produce protective traits, such as resisting drugs
- Because they can be readily manipulated in the lab and transferred from one cell to another, plasmids are important agent
  - In genetic engineering
  - recombinant DNA technology
  - Biotechnology.

Micro (10)
7/21/04

Bacterial External Structure:

Appendages: Cell extensions:

① **Flagella:**

Primary function is motility or self-propulsion.

Filament composed of proteins:

approx 20 nm = diameter

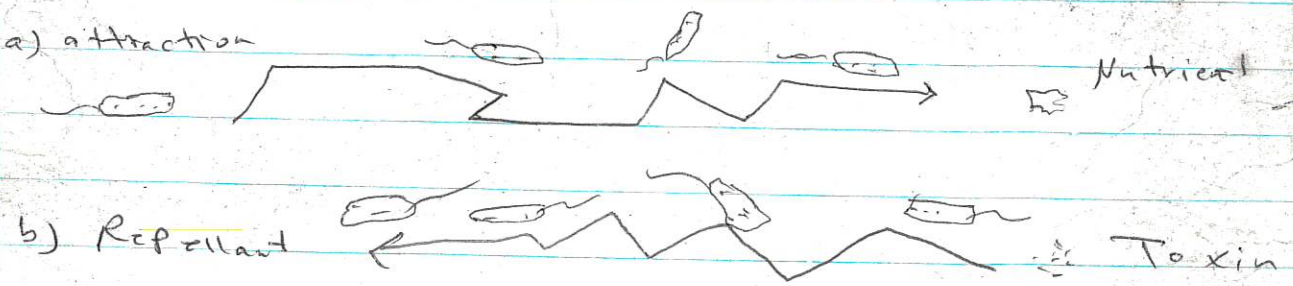
1–70 nm = length

Flagellated bacteria can perform → sophisticated/feats act

- Flagella allow bacteria to seek out favorable environments and avoid harful ones ⇒ This behavior is called **taxis**.

Chemotaxis:

Bacteria sense certain chemicals and swim toward regions that contain more nutrients and away from region with toxic materials



Aerotaxis: swim to regions that contain favorable concentration of dissolved oxygen

phototaxis: photosynthetic bacteria swim to regions of optimal light intensity

② **Pili (Pilus):**

Function attachment and mating

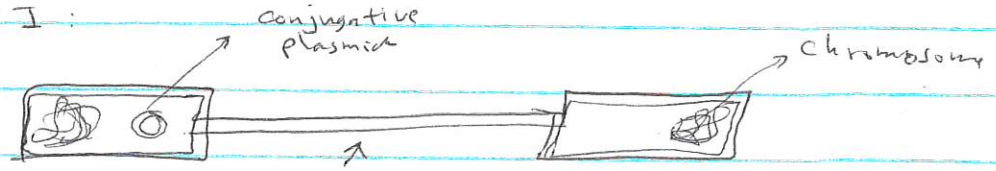
Pili are made of protein called pilins

Principal function of Pili is attachment → to surfaces, to bacterial or other cells.

Only in gram ⊖ve bacteria

- One type of pilus, called a sex pilus, attaches one bacterial cell to another during mating, called Conjugation: involves partial transfer of DNA from one cell to another.

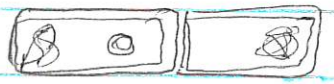
Step I:



Cells become attached by a sex pilus

Step 2:

The sex pilus retracts, bringing the cells together

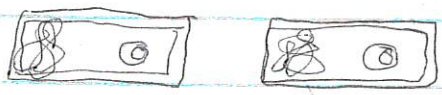


Step 3:

The conjugative plasmid is nicked and replication produces a single strand of DNA which enters the F⁻ cell.

Step 4:

The DNA in recipient cell is duplicated and forms into a circular plasmid. Both cells are now F⁺

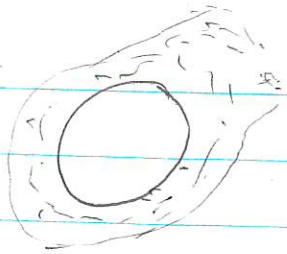


Cell envelope

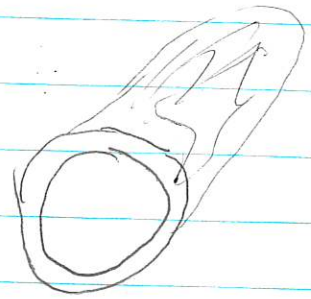
① Glycocalyx: bacterial surface coating, 2 kinds

a) slime layer: a loose, soluble shield to protect bacteria from loss of water and nutrients

Slime layer



b) Capsule:



made of repeating polysaccharide units and proteins, capsules are formed in a few pathogenic bacteria:

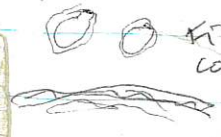
- Streptococcus pneumonia: a cause of pneumonia
- ~~Hemo~~ Haemophilus influenza: one cause meningitis
- Bacillus anthracis: the cause of anthrax.

Encapsulated bacterial cells have greater pathogenicity because capsules protect bacteria against WBC called phagocytes which are the natural body defense that can engulf and destroy foreign cells through phagocytosis, thus preventing infection

- A capsular coating blocks the mechanism that phagocytes use to attach to and engulf bacteria
- By escaping phagocytosis, the bacteria are free to multiply and infect body tissue.

Biofilms:

Glycocalyx can be important in formation of biofilms



Organic substrate →

Adsorption to surface →

growth of colonies →

Mature biofilm with microbial community

e.g: the white, thick white plaque that forms on teeth

Micro (1)
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2/21/05

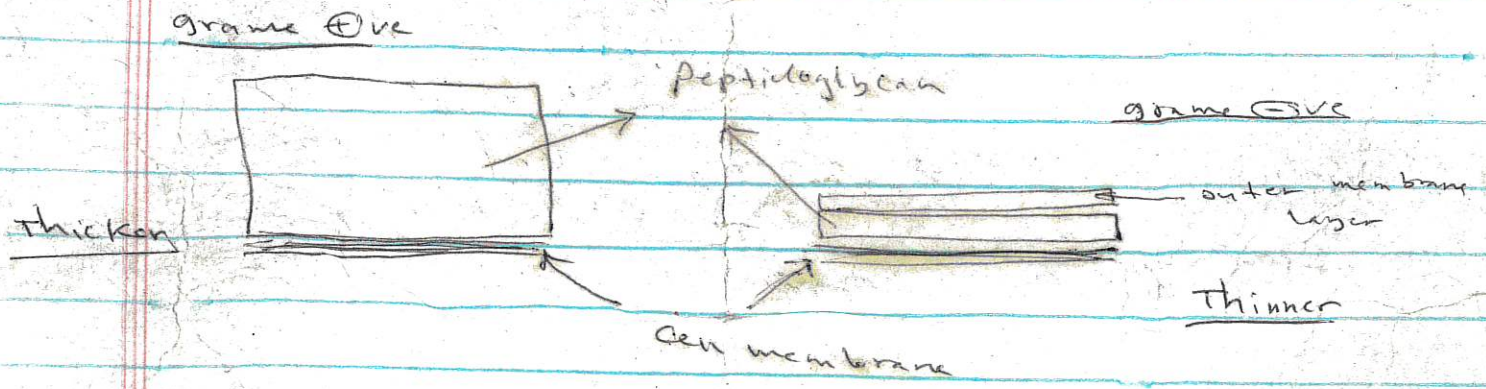
The Cell Wall

All bacteria except mycoplasms have
- strong - rigid Cell walls of Peptidoglycan
- Peptido = protein
- glycan = polysaccharide

Function of Cell wall:
1) Giving the cell its shape
2) Withstanding pressure

Structure:

Bacterial walls are made of Peptidoglycan



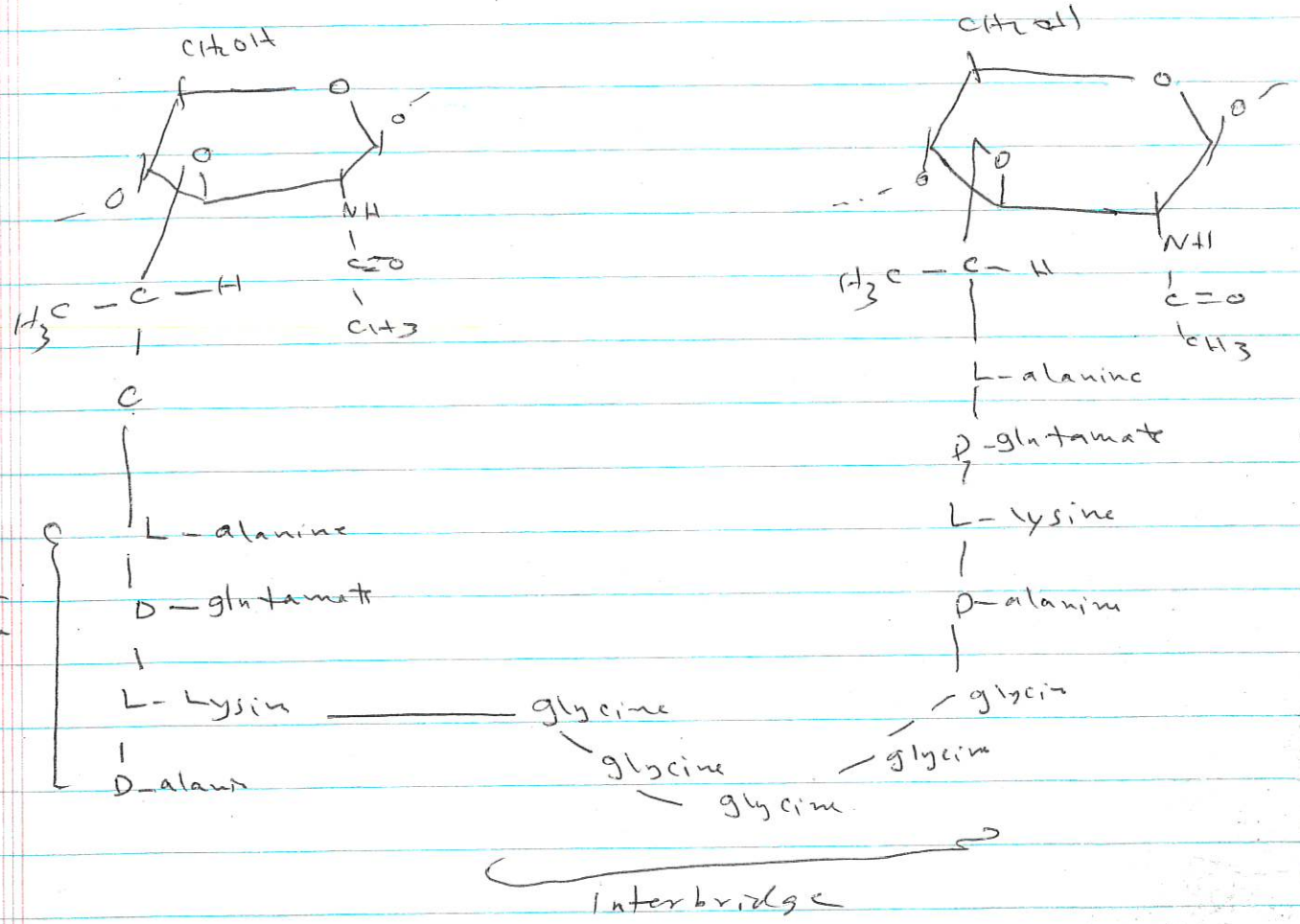
Gram +ve wall is thick peptidoglycan / many layer

Gram -ve is a peptidoglycan one layer thick

In staining

Step #3 Alcohol wash	appearance		chemical rxn	
	Gram +ve	-ve	Gram +ve	-ve
			Crystal remain in Cell wall	Cell wall partially dissolved / loses dye
Step #4 Safranin (red dye)			Red dye has no effect	Red dye stains the colorless cell

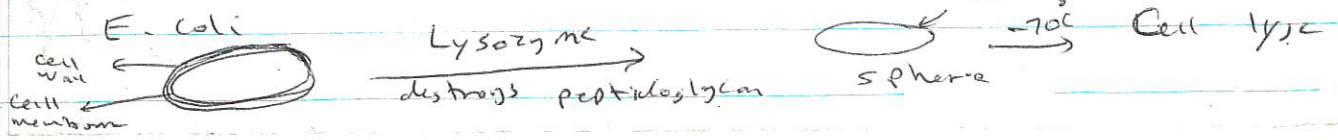
Peptidoglycan :



- Two amino acids are L-isomers (the form normally found in Protein)
- Two " " are D-isomer (a form that is rare in nature).
- The peptidyl chain and glycan when linked together create a single rigid mesh-like molecule

Cell Shape

The peptidoglycan cell wall confers (gives) shape on a bacterial cell wall



Bacteria come in many shapes : a) spherical = coccus

b) rod-shaped = bacilli, sing: bacillus

c) spiral = spirilla, sing: spirillum

e) other.

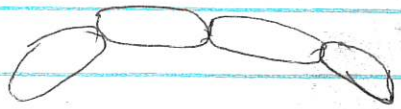
Coccus, spherical

- single
- diplococcus (pair)
- tetrad (groups of 4)
- streptococcus (chain)
- staphylococcus (cluster)

Bacillus, Rod

single

diplobacillus (pair)



streptobacillus (chain)

Spiral

spiral (corkscrew)

vibrio (comma-shaped)

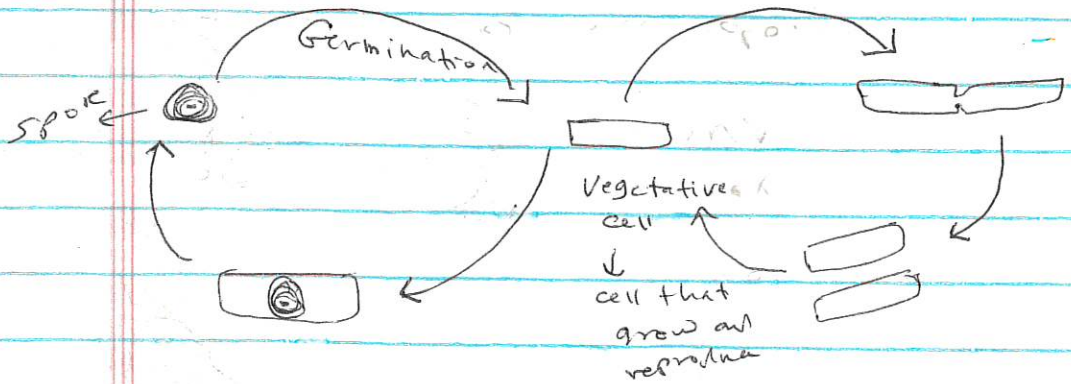
other

square

star-shaped

Endospores: Extremely resistant stage

Endo = it is produced inside a cell



Depends upon the availability of nutrients

- Depletion of nutrients → Stimulates for a vegetative cell to

Micro
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Unusual Forms of Medically Significant Bacteria

Two groups of bacteria:

a) Rickettsias b) chlamydias

- adapted to life inside their host cells
- considered obligate intracellular parasites.

Rickettsias:

Named ~~Boon~~ Howard Ricketts, a physician discovered it and later lost life to typhus.

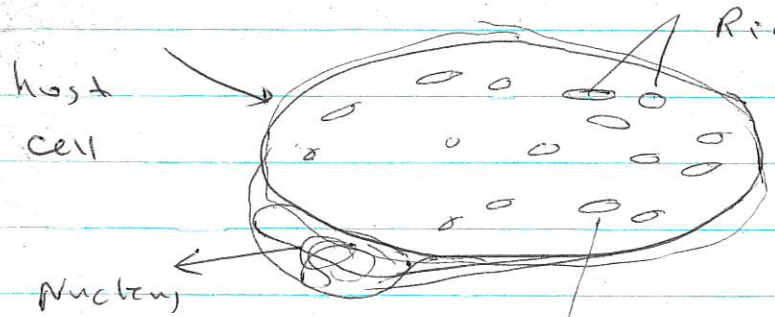
- life cycle → alternate between
  - a) a mammalian host
  - b) blood-sucking arthropods

such as fleas, lice, or ticks.

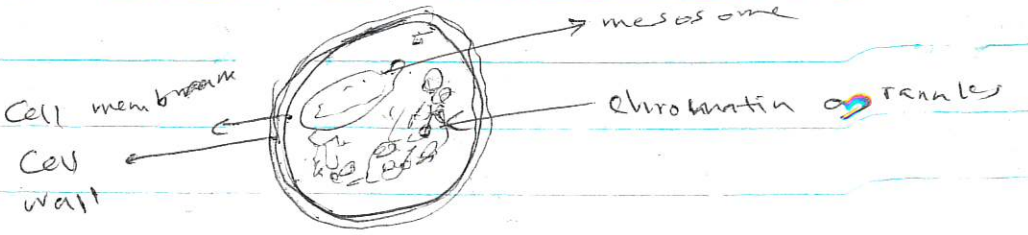
- cannot survive or multiply outside host cell — closely attached to their hosts.

Human diseases caused by rickettsias:

1) Rocky mountain spotted fever (transmitted by ticks)
2) Epidemic typhus (transmitted by lice)
3) Q fever (" " arthropods).



- identified as gram-negative bacteria



It is a tragedy that in this day of preventive medicine, millions of children worldwide will develop blindness for lack of a few dollars' worth of antibiotics.

The Chlamydia

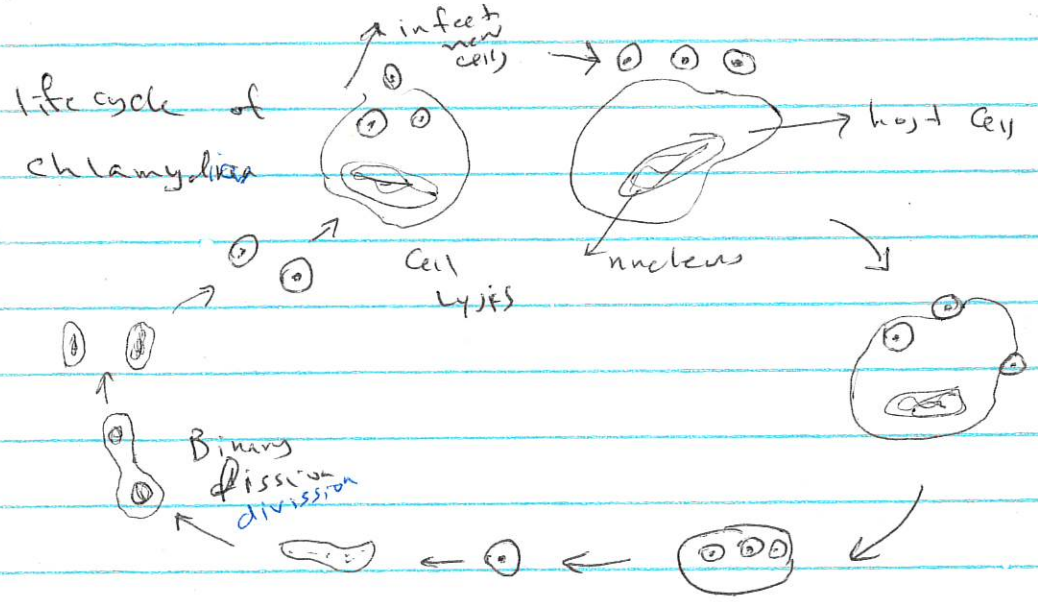
- are obligate parasite
- small size
- grame – negative cell way

Medical significance: Disease of Chlamydia trachomatis

Disease of the eye: most severe in infants and children → Africa, Asia → several million cases occurs

(Trachoma)

- attacks the squemous cells of mucous membrane in the eyes. Develop blindness



Free-living non-pathogenic bacteria:

1) photosynthetic bacteria:

use the sunlight energy to synthesize all required nutrients

2) Cyanobacteria: Blue-green bacteria; grow in fresh water and sea water, colored yellow-orange

3) Green and purple sulfur Bacteria:

utilize H_2S or S in their metabolism

Archaea:

- No peptidoglcan in walls of archaea makes it different from bacteria
- archaea all wall composed of protein or pseudomurein.

glycerol — O — C — CH_3 — fatty acid

(O above C)

Ester bond : chemical linkage in cell membrane in all organisms except archaea

glycerol — O — branched lipid

Ether bond.

Because ether bonds are stronger than ester bonds, archae have highly resistant cytoplasmic membrane that help archaea survive in extremely hostile environments : e.g: hight T, low pH, and high salt

- Members of the group:

Convert:

$CO_2 + H_2O \longrightarrow$ Methane gas (CH_4)

- lives in bottom sediments of lakes, ocean
- other type of archaea lives in 3% NaCl, that would destroy most cells. lives in salt lakes, salt mines
- others live at 80°C — 105°C, others at 25°C ~ high temperature

e.g. Volcanic water

Micro (13)

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Eukaryotic Cells and Microorganisms:

Eukaryoti Cells:-

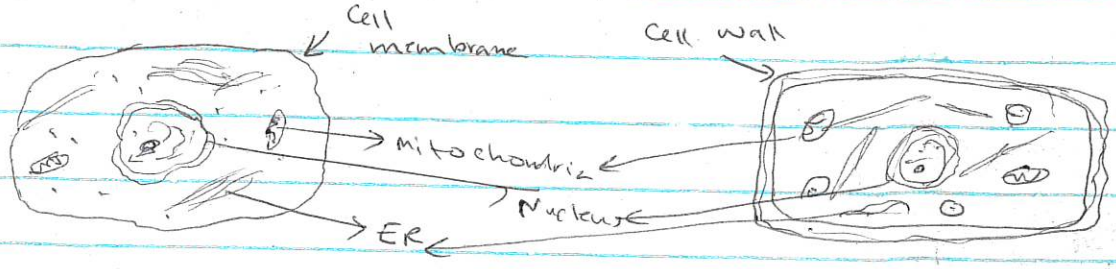
are

— large complex cells

— Divided into separate compartments by membrane-bound components called organelles

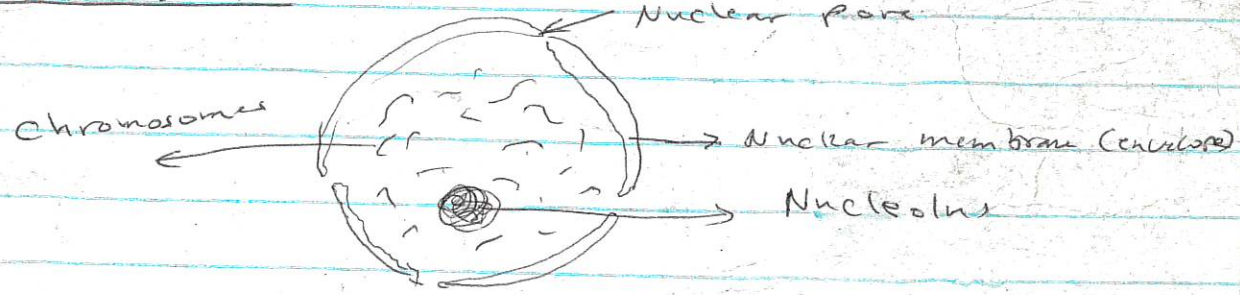
— Major organelles:

— Nucleus, — mitochondria, — chloroplast, — endoplasmic reticulum (ER), — Golgi apparatus.



Protozoa, Fungi, animal Algae, higher plant,

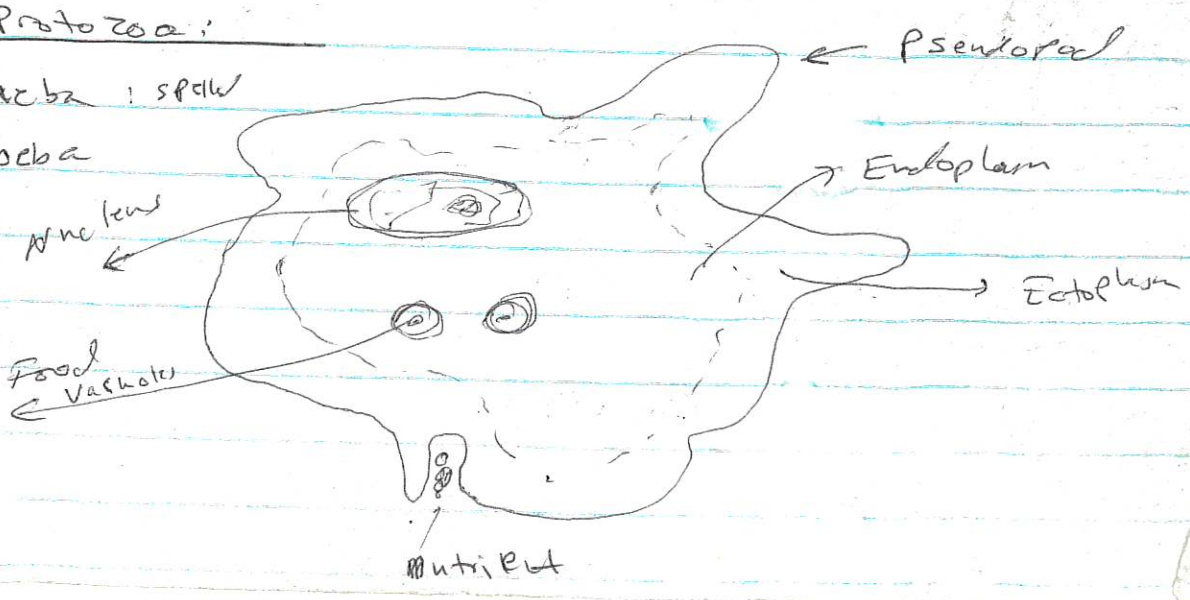
Nucleus:



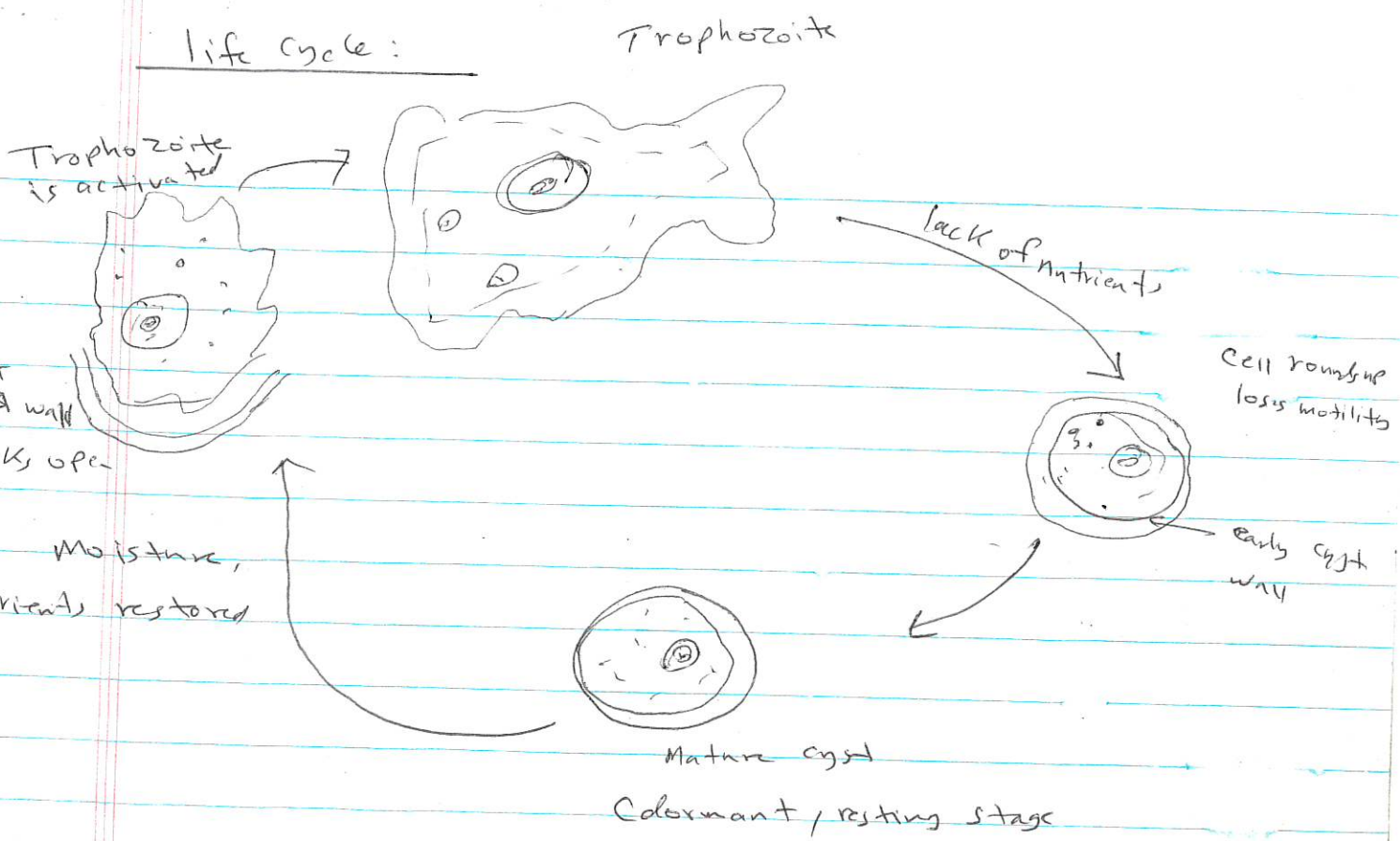
the Protozoa:

Amoeba: spelled

Amoeba



life cycle:



Infective Amebas: Entamoeba:

Amoebiasis
Giardiasis
African sleeping sickness
Leishmaniasis
Malaria

- Most common disease in human is amoebic dysentry
  → caused by Entamoeba histolytica
- widely distributed in the world from the northern zones to the tropics.
- Amebic dysentry is the fourth most common protozoan infection in the world
- life cycle above: it lives as
  a) trophozoite b) cyst

Cyst is resistant form, can survive in water & soil for several weeks. The primary way that people become infected is by ingesting food or water contaminated.

Stages in the infection:

① Mouth: cysts in food, water are eaten

2) the heavy walled cyst passes through the stomach unharmed

3) Inside small intestine, cyst germinates (divides) → to form small amebas = trophozoite

4) Large intestine: Feed & grow

↓ can penetrate the lining of intestine and invade Liver, lungs, & skin

5) cycle is completed, In feces, cysts form → pass out of the body with fecal matter

Common Symptoms:

- Gastrointestinal disturbances, e.g. nausea, vomiting, diarrhea mixed with blood
- leading to weight loss and dehydration
- extensive damage → high death rate

Preventive measures:

- Sewage treatment
- No use of human feces as fertilizers
- Adequate sanitation of food and water.

Flagellated Protozoa

a) Giardia: an intestinal parasite: spread in water contaminated with feces.

b) Trichomonas vaginalis: transmitted via sex.