2018 MICROBE MISSION – TRAINING HANDOUT

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DISCLAIMER - This presentation was prepared using draft rules. There may be some changes in the final copy of the rules. The rules which will be in your Coaches Manual and Student Manuals will be the official rules.

***BE SURE TO CHECK THE 2018 EVENT RULES* for EVENT PARAMETERS and TOPICS FOR EACH COMPETITION LEVEL**

TRAINING MATERIALS:

- **Training Power Point** presents an overview of material in the training handouts
- **6 Training Handouts** presents introductory topic content information – **1 General Handout and 5 Handouts for Major Areas of Microbe Importance**
- **Practice Activities – Sample Lab Stations with keys**
- **2 Sample Tournament**s has sample problems with key
- **Event Supervisor Guide** has event preparation tips, setup needs and scoring tips
- **Internet Resource & Training Materials** are available on the Science Olympiad website at www.soinc.org under Event Information.
- **A Biology-Earth Science CD**, a **Microbe Mission CD** as well as the **Division B and Division C Test Packets** are available from SO store at www.soinc.org

Event Format :

- This is a lab-orientated competition to answer questions, solve problems, and analyze data pertaining to various kinds of microbes.
- Content topics for Division B and C are listed in the rules and the level of reasoning and math skills should be consistent with the grade level.
- **Be sure to check the event parameters in the rules for the resources allowed and type of goggles required.**

MICROBE MISSION AND OTHER SCIENCE OLYMPIAD EVENTS:

- **Disease Detective –** 2018 topic is Food Borne Illness (many are microbial caused)

MICROBES

- The term microbe is short for microorganism which means small organism – observed with a microscope
- Over 99% of microbes contribute to the quality of human life
- A small minority cause disease – in humans by sheer numbers or producing powerful toxins
- The major groups of microbes are bacteria, archaea, algae, fungi, protozoa & viruses
- In terms of numbers, microbes represent most of the diversity of life on Earth and are found in every environment.

MICROSCOPES – See the **2017 MICROSCOPE REVIEW** for a review of the Relative Size of Microbes, Types of Microscopes, Parts of a Microscope and the Principles of Microscopy.

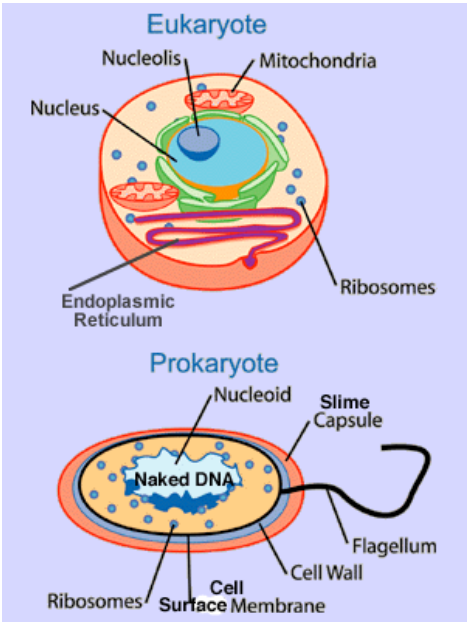
CELLULAR LIFE - All cells have the following

- Has a membrane that separates the cell from the outside world
- Contains a nucleic acid as its genetic material (DNA or RNA)
- Use their genetic material to produce protein – structural or functional as enzymes and hormones
- Are composed of basic chemical as carbohydrates, proteins, fats, nucleic acids, vitamins, & minerals
- Regulate the flow of nutrients and wastes entering and leaving the cell
- Reproduce and are the result of reproduction
- Require a source of energy
- Interact with their environment

CELLULAR VS. ACELLULAR

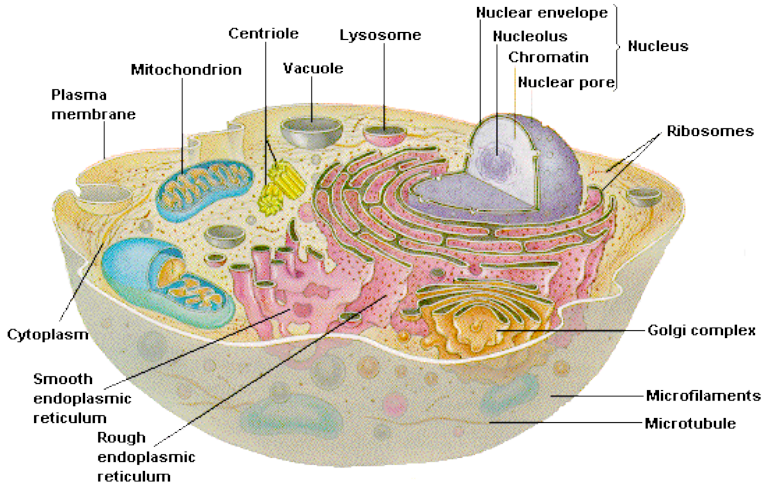
- **Acellular –** Viruses do not have cellular components, nor do they grow or metabolize organic materials. They generally consist of a piece of nucleic acid encased in protein which must use the cellular components of a living cell to reproduce. Prions (**pr**oteinaceous **i**nfectious particles) are infectious agents composed primarily of protein which induce the existing polypeptides in host cells to take on its form.
- **Cellular –** bacteria and Archaea are prokaryotic cells while algae, fungi, and protozoa have eukaryotic cells.

PROKARYOTIC VS EUKARYOTIC CELLS

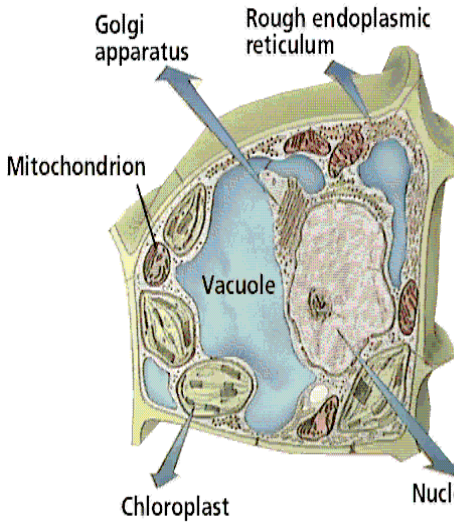


Comparison

- **Prokaryotic –** single celled microorganism (archaea and bacteria) with nuclear material but no nuclear membrane or membrane bound organelles
- **Eukaryotic –** most cells – with organized nucleus and membrane bound organelles



Eukaryotic Animal Cell



Eukaryotic Plant Cell

Surface of Cell:

- **Cell Wall** – commonly found in plants cells – protection & support
- **Plasma Membrane –** control of substances coming in and out
- **Cilia -** sweep materials across the cell surface
- **Flagellum -** enables a cell to propel and move in different directions

  Cytoplasm – between plasma membrane and nucleus – many organelles
- **Endoplasmic reticulum (ER)** is the passageway for transport of materials within the cell
- Synthesis of lipids – modification of newly formed polypeptide chains
- **Ribosomes** are the site of protein synthesis
- **Golgi apparatus**- Final modification of proteins & lipids Packing of materials for secretion of the cell
- **Mitochondria** are the site of aerobic cell respiration-ATP production
- **Lysosomes** contain enzymes to digest ingested material or damaged tissue
- **Chloroplasts –** store chlorophyll – photosynthesis light reaction
- **Vacuoles –** storage – increase cell surface area
- **Centrioles -** organize the spindle fibers during cell division
- **Cytoskeleton** – cell shape, internal organization, cell movement & locomotion

Nucleus: - control center of the cell

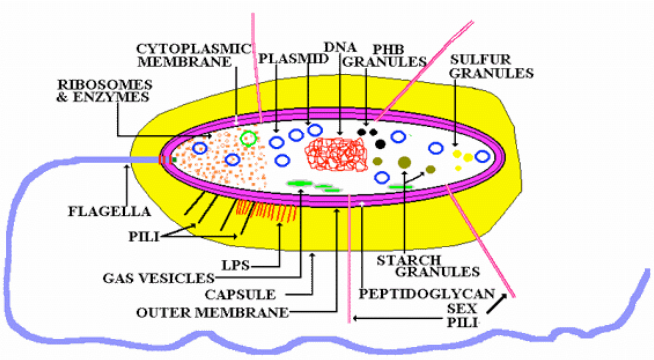
- **Nuclear membrane –** membrane around nucleus – controls movement in an out
- **Nucleolus** – assembly of subunits of ribosomes.
- **DNA** - encoding of heredity information
- **RNA** – transcription and translation of DNA coding into proteins

Organelles of Microbial Origin

- Eukaryotic cells are structurally and biochemically more complex than Eukaryotic cells
- There is strong evidence to suggest that Eukaryotic cells came from aggregates of Prokaryotic cells that became interdependent and eventually fused into a single larger cell.
- **Nuclear material –** is found in both Prokaryotic and Eukaryotic cells
- **Mitochondria –**have DNA similar to that of a Prokaryotic cell and can reproduce independent of the rest of the Eukaryotic cell.
- **Chloroplasts** – also have DNA similar to that of a Prokaryotic cell and can reproduce independent of the rest of the Eukaryotic cell.

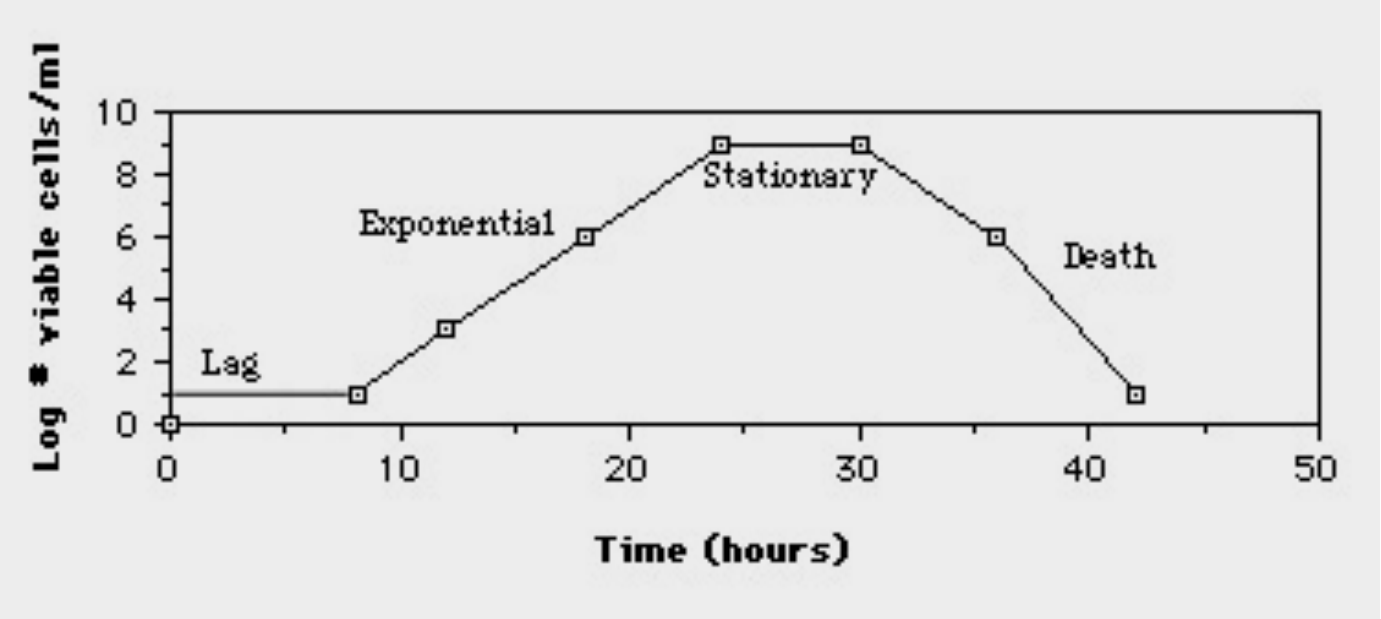
BACTERIA

Composite of possible structures for bacterial cell



- Consist of only one cell – a prokaryotic cell
- Live in all environments – even above boiling point and below freezing point
- Are basically three shapes – spherical , rod, and spiral or helical
- Exist as individuals or cluster together to form pairs, chains, squares, or other groupings
- Some are **photoautotrophic** - make their own food as plants and give off oxygen – **Cyanobacteria** are also aerobic – use oxygen for respiration **Purple and green bacteria** are anaerobic
- Some are **chemoautotrophic** - synthesize their own food using energy from chemical reactions – important for recycling in nitrogen and sulfur cycles
- Some have flagella - rotates like a tiny outboard motor, others secrete a slime layer and move over surfaces like slugs, while others are immobile.
- Some form spores

MICROBIAL GROWTH CURVE



Measuring bacterial growth:

Optical Density: using a spectrophotometer to measure the turbidity (cloudiness) of a bacterial culture

Plate counts: dilute and plate bacterial cultures, count the number of colonies that form to determine Colony Forming Units per mL (CFU/mL)

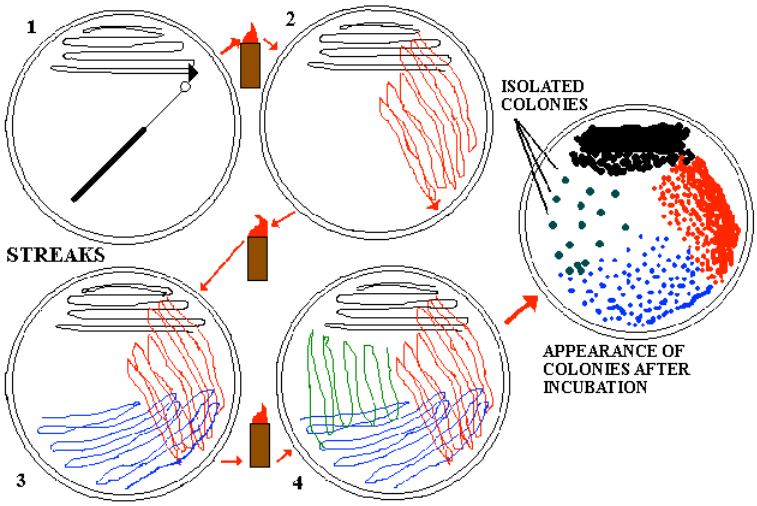
Quantifying DNA or Protein: extract DNA and protein from bacterial culture and quantify using laboratory assays

Isolation of bacteria

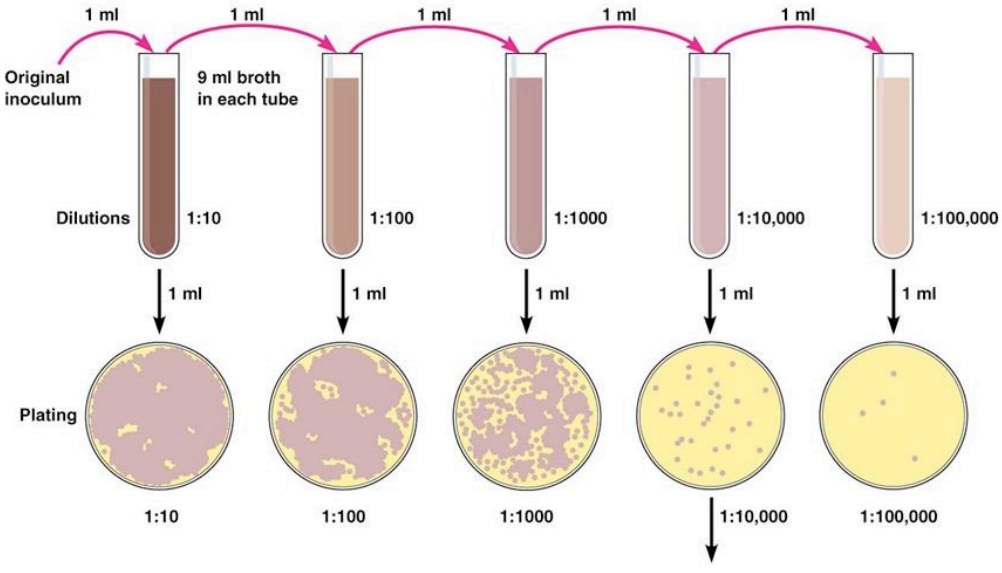
Streaking for isolation: spread a heavy streak of cells with a sterile stick or loop; re-sterilize stick or loop with flame, pull cells from previous streak, and dilute by dragging stick or loop across plate; repeat until cells sufficiently diluted to form isolated colonies.

Serial dilution and plating: dilute culture 10-fold (ex: 1mL of culture into 9mL of fresh medium); transfer same volume of first dilution to a second tube with the same amount of fresh media, generating a 100-fold dilution, continue until 10^6 dilution has been made; spread volumes of each dilution on plates; count colonies that form; determine Colony Forming Units per mL of medium (CFU/mL).

Streaking for isolation:

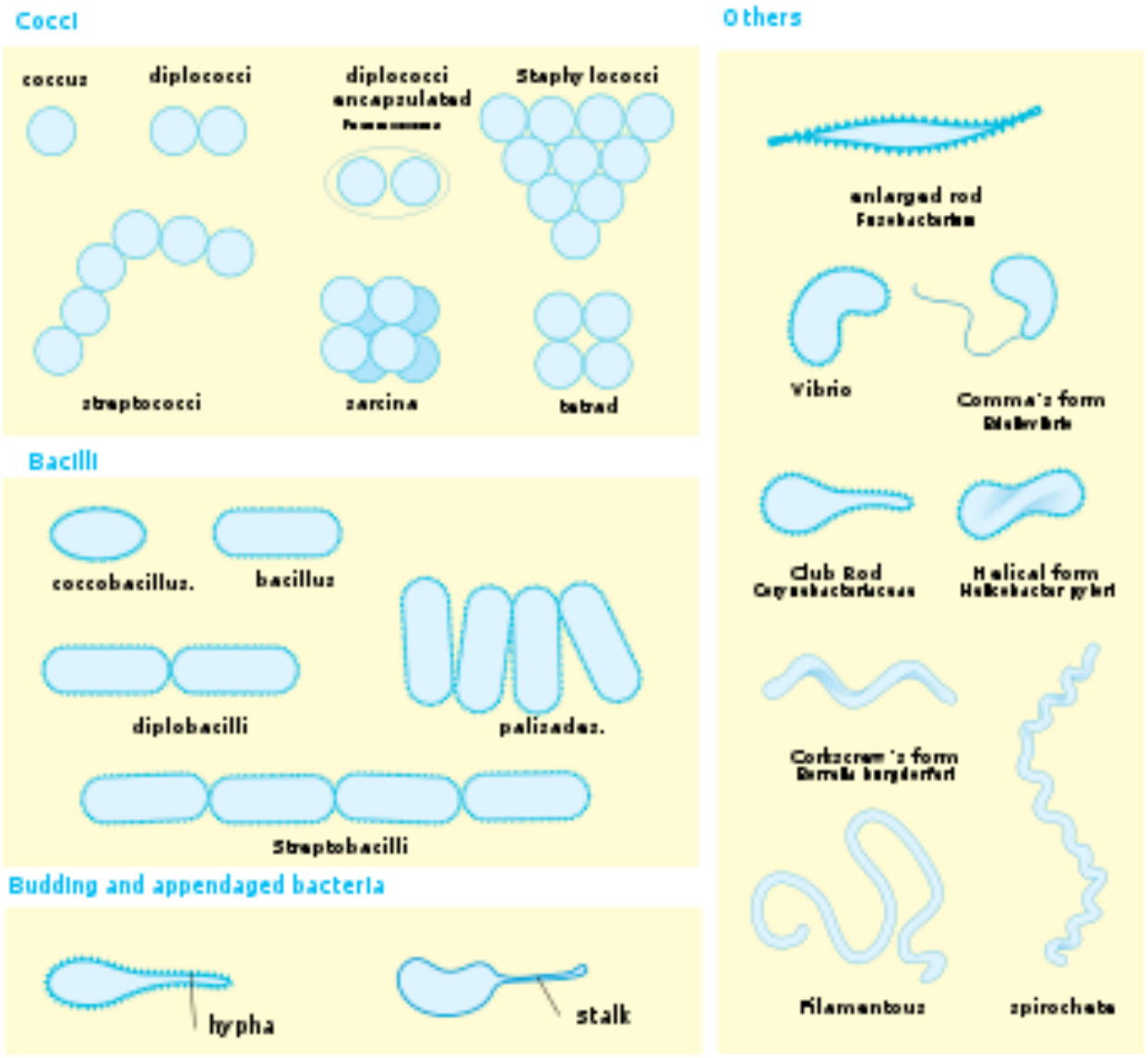


Serial dilution and plating:



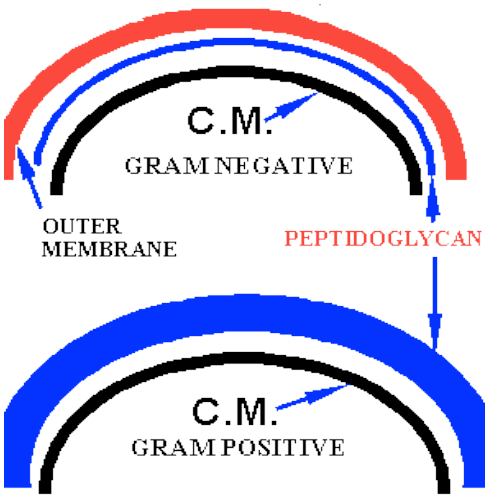
Calculation: Number of colonies on plate × reciprocal of dilution of sample = number of bacteria/ml
(For example, if 32 colonies are on a plate of $^1/_{10,000}$ dilution, then the count is 32 × 10,000 = 320,000 bacteria/ml in sample.)

BACTERIAL SHAPES



- **bacillus** is rod-shaped
- **coccus** is ball-shaped
- **spirilium** is spiral-shaped
- **vibrio** is comma-shaped
- **cocco-bacillus** is ovoid-shaped
- other combinations

BACTERIAL SHAPES, GRAM + AND GRAM -



Gram positive bacteria
- stain purple under Gram stain
- have a thick bilayer wall of the polymer peptidoglycan.

Gram negative bacteria
- stain red
- have a thin layer of this polymer and an additional lipopolysaccharide outer layer, LPS,
- often endotoxic - capable of initiating inflammation and cell-mediated immune responses
- e.g., *Salmonella*, *Shigella*, and *Escherichia*.

ARCHAEA

- Are Prokaryotic
- Similar to bacteria in many characteristics
- Cell walls lack peptidoglycan + other differences
- Origin very old - during formation of the earth
- Extremely tolerant to heat, acid, and toxic gases
- Found in extreme habitats in anaerobic environments to produce methane, high salt concentrations or hot acid environments
- Involved in carbon & nitrogen cycles, assist in digestion, & can be used in sewage treatment

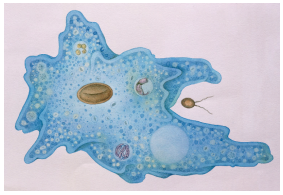
ALGAL PROTISTS (ALGAE)

diatoms

- Are Eukaryotic
- Found in fresh and salt water environments
- Can live on rocks, trees, and in soils with enough moisture
- Can carry on photosynthesis – produce large amount of oxygen for life on earth
- Diatoms, *Volvox*, *Clamydomonas* , *Spirogyra*
- Shells of diatoms – silica – mined to make abrasives
- Algal blooms can use up oxygen in water – harming other organisms as fish

ANIMAL-LIKE PROTISTS (PROTOZOA)

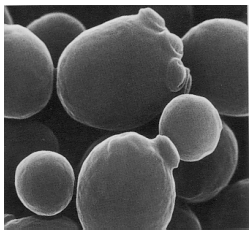
Amoeba



- Protozoa means "little animal" – act like tiny animals - Eukaryotic
- Hunt other microbes for food
- Mainly feed on bacteria, also other protozoa and some algae
- Digest food in digestive organelles
- Ciliates, Amoebaes, Flagellates – organized by mode of transportation
- Amoeba, Paramecium, Euglena are examples
- Most are not harmful – a few are harmful
- Certain protozoa can cause dysentery and malaria

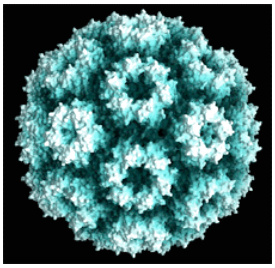
FUNGI

Yeast



- Cellular level, more like animals than plants – Eukaryotic
- Can't synthesize their own food
- Single celled as **yeast** or multicellular clusters as **molds & mushrooms**
- Multicellular ones form filament like strands – hyphae
- Grow best in slightly acidic environment – can grow in low moisture
- Live in soil, on plants & animals, in fresh & salt water
- One teaspoon of topsoil has about 120,000 fungi
- **Baker's yeast** for bread and brewing, some fungi are used for antibiotics, others are decomposers in the ecosystem
- Some cause disease in humans, animals and plants – ruin ¼ to ½ of fruits & vegetables per year

VIRUSES



- Are acellular
- Consists of a piece of nucleic acid (DNA or RNA) encased in protein and in some cases a membrane-like envelope
- They come in many shapes
- Found anywhere there are cells to infest
- Exist to reproduce – must take over a suitable host cell
- Uses the cell machinery of the host cell to reproduce

PRIONS

- proteinaceous infectious particles, associated with a number of diseases such as
  - **Creutzfeld-Jacob disease** (CJD) in humans
  - **Gerstmann-Straussler-Scheinker syndrome** (GSS) in humans
  - **Alpers syndrome (**in infants),
  - **Fatal Familial Insomnia** (FFI) in humans
  - **Kuru** in humans
  - **Scrapie** in sheep,
  - **Bovine Spongiform Encephalopathy** (BSE) or Mad Cow Disease in cattle
  - **Chronic Wasting Disease** (CWD) in wild ungulates such as Mule deer and elk
- These diseases are characterized by loss of motor control, dementia, paralysis, wasting and eventually death.

BENEFICIAL VS HARMFUL MICROBES

Beneficial vs. Harmful Bacteria

- Most are beneficial (over 99%) contribute to the quality of human life
- They live in every environment on earth
- Microbes are important in ecological systems
- They are important to biogeochemical cycles
- Human digestion depends upon them
- They are important to the food industry and the productions of many products
- Microbes help with wastewater and oil spill cleanup
- A small minority of microbes cause disease

FOOD PRODUCTION

- Milk into yogurt, buttermilk, sour cream, cheese
- Aid in production of chocolate, bread products, wine, beer, tea
- Pickling process to make pickles from cucumbers and sauerkraut from cabbage

FOOD SPOILAGE AND DECOMPOSITION OF FOOD

- Microbes play a key role – bacteria and fungi – in food spoilage and decomposition
- Many types can live at low temperatures as mold on food in the refrigerator
- Food preservation techniques as salt and high acid affect microbes

FERMENTATION PRODUCTS

- Carbon dioxide – bread making using baker's yeast
- Alcohol – wine making and brewing using yeast
- Lactic Acid – lactic acid bacteria ferment milk into products as **yogurt**

INDUSTRIAL USES

- Microbes (fungi and bacteria) are used to make antibiotics
- Algae are being used to make petroleum
- Yeast and bacteria are used in producing medicines

MICROBIAL ECOLOGY

- Major producers in aquatic environments
- Decomposers – bacteria and fungi – in many ecosystems
- Key role in Biogeochemical cycles to recycle carbon, nitrogen, carbon, water
- Natural pest killers in gardens and on crops
- Breakdown oil from oil spills
- Serve as natural water treatment
- Can cause some ecological problems as red tide and algal blooms
- Involved in many symbiotic relations as lichens, human digestion, rumens of cows
- Key in maintaining ecological balance on Earth

WASTEWATER MICROBIOLOGY

- Microbes play a key role in drinking water and waste treatment facilities
- Are involved in natural waterways
- Involved in maintaining septic tanks
- Coliform bacteria as E. coli can contaminate water making it unsafe

MICROBIAL DISEASES

- There are many agents of infectious diseases
- Microbes acting as agents are prions, viruses, bacteria, fungi, protozoa, parasitic worms
- Examples of common diseases for each to follow

Be sure to check the SO National website for the final 2018 List of Diseases

2018 MICROBIAL DISEASES –5-21-2017 (New in red bold)

VIRAL DISEASES

- AIDS
- Chicken Pox & Shingles
- Common Cold
- Dengue Fever
- Ebola Hemorrhagic Fever
- Hepatitis
- Influenza
- Measles
- Mumps
- Mononucleosis
- Polio
- Rabies
- Rubella
- **Zika**
- **Norovirus**
- Yellow Fever

BACTERIAL DISEASES

- Anthrax
- Botulism
- Cholera
- Chlamydiasis (Chlamydia)
- Dental Caries (tooth decay)
- Legionnaire's Disease
- Lyme Disease
- MRSA
- Peptic Ulcer Disease
- Pertussis (whooping cough)
- Rocky Mountain Spotted Fever
- Strep throat
- Syphilis
- Tetanus
- Tuberculosis

FUNGAL DISEASES

- Athlete's foot
- Dutch Elm Disease
- **White Nose Syndrome**
- Histoplasmosis
- Potato Blight - *Alternaria solani*
- Ringworm
- Thrush

PROTOZOAN/ALGAL DISEASES

- Malaria
- Paralytic Shellfish Poisoning
- **Naegleria**
- Giardiasis
- Cryptosporidiosis

PRION DISEASE –Chronic wasting disease and Kuru

PARASITIC WORMS

- Hookworm
- Pinworm
- Schistosomiasis
- Tapeworm
- Trichinosis

NATIONAL TOURNAMENT – ADDED DISEASES IMPORTANT GENERA

- *Wolbachia*
- ***Pseudomonas aeruginosa***