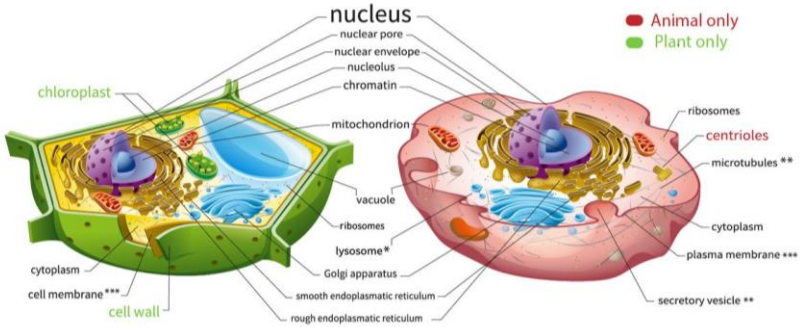
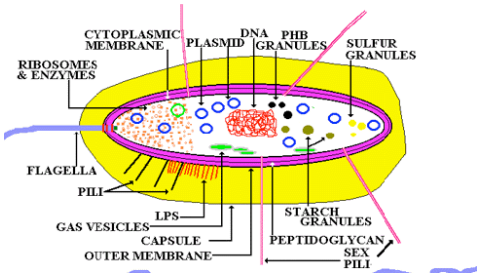
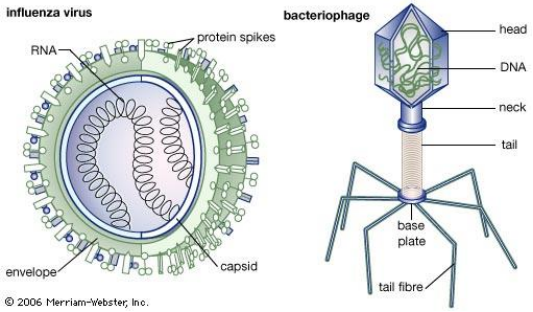
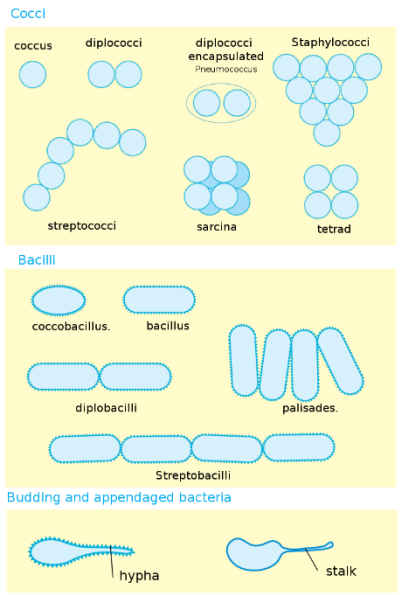




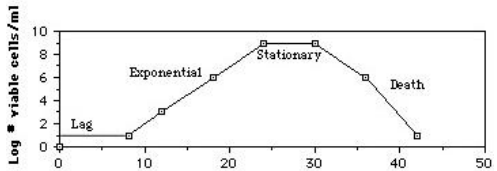


Organelles of Microbial Origin• Eukaryotic cells are structurally and biochemically more complex than Eukaryotic cells• There is strong evidence to suggest that Eukaryotic cells came from aggregates of Prokaryotic cells that became interdependent and eventually fused into a single larger cell. • **Nuclear 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. **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 106 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). **Gram staining:** When you separate bacteria into 2 different groups using staining. **2 types-. Gram positive bacteria:** When dyed with violet dye. These bacteria look purple. This is because their cell walls are made of peptidoglycan. **Gram negative bacteria**: Bacteria that retain a red-pink color. They have a thin membrane of peptidoglycan squash in between an outer and inner membrane. **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) (ex:*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) (ex: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 (ex: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 o **Creutzfeld-Jacob disease** (CJD) in humans o **Gerstmann-Straussler-Scheinker syndrome** (GSS) in humans o **Alpers syndrome (**in infants), o **Fatal Familial Insomnia** (FFI) in humans o **Kuru** in humans o **Scrapie** in sheep, o **Bovine Spongiform Encephalopathy** (BSE) or Mad Cow Disease in cattle o **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 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. **AIDS** disease of the human immune system caused by the HIV virus 2. **Chicken Pox & Shingles** diseases caused by the varicella zoster virus (VZV) 3. **Common Cold** viral infection of the upper respiratory tract nose and throat 4. **Dengue Fever** viral infection from bite of an infected mosquito; usually in the tropics 5. **Ebola Hemorrhagic Fever** viral illness from Ebolavirus with severe bleeding 6. **Hepatitis** infectious liver disease - three viruses most common - a,b, and c 7. **Influenza** viral; commonly called the flu, highly infectious respiratory infection 8. **Measles** contagious virally infectious disease with an itchy skin rash 9. **Mumps** viral infection of the parotid glands located below and in front of the ear 10. **Mononucleosis** "kissing disease" caused by Epstein-Barr virus 11. **Polio** viral highly infectious disease that invades the nervous system and can cause paralysis 12. **Rabies** viral potentially deadly infection of the brain spread by infected animals 13. **Rubella** viral infection of skin by rubella virus - commonly called German measles 14. **Small pox** viral disease causes extensive (raised bumps) rash, fever - can be deadly. 15. **Yellow Fever**: subtropical illness caused by the yellow fever virus. It is mosquito-borne, and is most commonly associated with Aedes aegypti.16. **Zika**:a disease

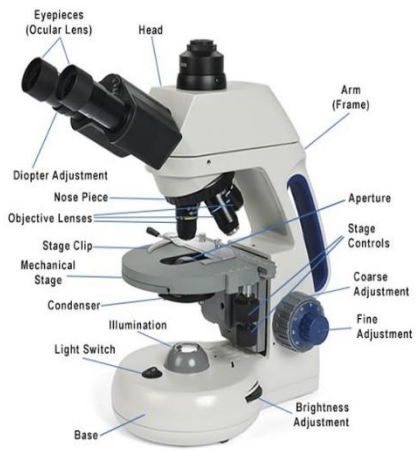


caused by the zika virus, which is part of the Flaviviridae family. it is transmitted through Aedes mosquito bites and can also be vertically transmitted from mother to child. **Bacterial Diseases** **Anthrax**: a serious and rare infectious disease caused by the bacteria Bacillus anthracis. People may become sick with anthrax if they come in contact with infected animals or contaminated animal products. **Botulism** :a serious food borne illness caused by Clostridium botulinum. It is found in canned foods and the spores can be found in honey, but the pores do not pose a threat to anyone with a developed immune system. **Cholera**: a bacterial infection spread in contaminated water. It can be very severe and dangerous if untreated. Cholera is caused by two serotypes of Vibrio cholerae, O1 and O139. **Dental Caries**: commonly known as cavities, are most commonly caused by two Streptococcus bacteria, S. mutans and S. sobrinus. **Lyme Disease**: a bacterial infection spread by ticks carrying the pathogen Borrelia burgdorferi. The disease is named for the place where it originates: Lyme, Connecticut. **MRSA**:**Methicillin**-resistant Staphylococcus aureus, is a type of bacteria that is resistant to many types of antibiotics. This infection is often healthcare-associated, so proper sanitation measures should be taken in hospitals. **Peptic Ulcer Disease**: causing agent Helicobacter pylori. These bacteria are able to resist the antimicrobial effects of stomach acid and colonize the stomach mucosa, resulting in the formation of ulcers. H. pylori is a risk factor for stomach cancer. **Pertussis**: also known as the whooping cough, is a disease caused by the bacteria Bordetella pertussis. Pertussis most commonly affects children, and spreads easily through the coughs and sneezes of an infected person. **Pseudomonas aeruginosa** (Nationals Only):The pathogen is in the name of the disease, for starters. It mainly affects weak people. Furthermore, it is almost always a nosocomial infection, meaning that outbreaks originate in a hospital. There is no definitive mode of transmission, but airborne infection is a possibility. **Rocky Mountain Spotted Fever** (RMSF): is a bacterial infection spread through ticks carrying the bacteria Rickettsia rickettsii. **Strep throat**: is caused by streptococcus bacteria, namely Streptococcus pyogenes. **Syphilis** is a sexually-transmitted disease spread by the bacteria Treponema pallidum. **Tetanus**: is an infection that affects the muscles and nervous system, causing them to spasm. It is caused by the bacteria Clostridium tetani. **Tuberculosis** (TB): is an infectious disease caused by the bacteria Mycobacterium tuberculosis. Roughly one-third of the world's population is thought to have TB, of which about 10% develop the disease. **Wolbachia** (**Nationals Only**)Bacteria of the Wolbachia genus only affect insects (lucky for us, because they are called "gonad-chomping parasites"). These bacteria are vertically transmitted from an infected mother to her offspring (yes, males are useless once again). **Fungal Diseases** **Athlete's foot**:an infection caused by Tinea pedis, a dermatophyte fungus. Can get this illness by walking barefoot. **Dutch elm** disease: only affects dutch elm trees. The fungus is transmitted through bark beetles that attack the trees. **Early potato blight**: was a major factor of the Great Famine in Ireland. Affects potatoes. **Histoplasmosis**: a disease caused by the fungus Histoplasma capsulatum. Affects the lungs, but occasionally can affect other organs. **Ringworm**: caused by the fungus Trichophyton rubrum. It can be transmitted through direct skin-to-skin contact or through objects that an infected person has touched. **Thrush**: caused by the buildup of Candida albicans in the mouth. **White Nose Syndrome** (WNS): an infection of bats caused by the fungus Pseudogymnoascus destructans. WNS is named for the white fungus that typically appears on a bat's nose. **Protozoan & Algal Diseases** **Cryptosporidiosis** or "crypto": is caused by the Cryptosporidium parasite transmitted through contaminated food and water. **Giardiasis**: a foodborne intestinal infection caused by the Giardia parasite. Aside from contaminated food and water, giardiasis can also be transmitted through touching contaminated objects. **Malaria**: a disease caused by multiple parasites. They are all spread by mosquitoes. It can cause flu-like symptoms in addition to vomiting, yellow skin, comas, seizures, and death. Naegleria: a freshwater illness caused by protozoa. This illness is extremely rare, and to get this illness, you must nasally inhale contaminated freshwater (can't get illness by drinking). The illness has two stages: the first with very basic and harmless symptoms, and the second ending in a coma. Naegleria is fatal and only five survivals have been recorded. **Paralytic Shellfish Poisoning** (PSP): an algal infection caused by eating contaminated shellfish. PSP is caused by dinoflagellates and is commonly associated with algal blooms. **Prionic Diseases**:**Chronic Wasting Disease** (**CWD**): exclusively affects deer, elk, reindeer, moose, and similar animals, and it might be the origin of scrapie. Possible modes of transmission are contaminated soil, water and food, as well as infected urine, saliva, or feces. **Kuru**: This is a unique prion disease that occurs in humans, spread by cannibalism. In the past, the Fore tribes in Papua New Guinea engaged in funerary cannibalism as part of their culture. **Parasitic Worms: Hookworm**: an intestinal parasite that affects humans and other animals. The worm can be acquired through either ingestion or fecal transmission. **Pinworm**: intestinal parasitic worms. After infection, the worm lays ten to fifteen thousand eggs around the anus of the infected individual. **Schistosomiasis**:or bilharzia is a freshwater illness most common in the subtropics caused by parasitic flatworms. **Tapeworm**: infections are usually caused by two tapeworms of the Taenia genus. In order to get an infection, you must consume the larvae, which are found in infected animal meat.

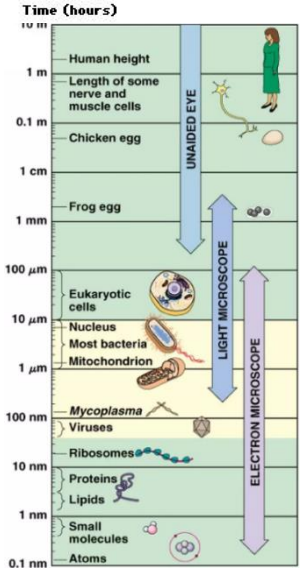
Trichinosis: an infection caused by the parasitic roundworms of the Trichinella genus. **Microbial growth curve:** This is used to determine the growth of microbes, typically bacteria.[1]**Lag phase** Where the microbes get ready for doubling, synthesis of RNA, enzymes, etc.[2]**Log** (**exponential**) **phase**: This is the phase where microbes go through constant doubling. The more odds are in their favor, the longer the slope, the faster microbes grow, and the steeper the slope. This is the phase where generation time can be calculated. The equation is G (generation time) = t(time) /n (number of generations) [3] **Stationary phase** There is no significant change in the amount of microbes in this phase. This is because the amount of microbes dying is equal to the amount being made.[4] **Death** (**decline**)**phase**:This is the phase where the microbes begin to run out of nutrients. The slope shows how the amount of dying cells is greater than the amount being made.



MICROSOCOPES: Parts of the microscope and their function: The number in front of each part of the microscope represents its number on the diagram. 1. **ocular** - magnifies the image formed by the objective.2. **nosepiece** - holds the objectives.3. **objectives** - lenses that receive the light from the field of view and form the first image. 4. **stage** - supports the slide and the specimen.5. **stage clips** - hold the slide in place.6. **base** - foundation which supports the scope & keeps it stable.7. **diaphragm** - controls the amount of light reaching the specimen. 8. **illuminator** - source of light. 9. **course adjustment** - used for initial or low power adjustment.10. **fine adjustment** - used for fine tuning & high power focusing. 11. **arm** - supports the ocular, objectives and body tube.12. **body tube** - tube or barrel between the ocular and the objectives.



TYPES: **Visible Light(up to 2000X):**[1]**Bright Field Microscope** (Lab – Light **Compound** Microscope).[2] **Dark Field Microscope** [3]**Phase Contrast Microscope** [4]**Differential - Interference** Microscope.**Ultraviolet rays(up to 2000X):**[1]**Fluorescence Microscope** [2]**Confocal Microscope**.. **Electron beam:** • Originally developed for studying nonbiological materials• Biologists began using it in the early 1930s• Forms an image with a beam of electrons o Electrons travel in wavelike patterns 1,000 times shorter than visible light waves o This increases the resolving power tremendously • Magnification can be extremely high (between 5,000X and 1,000,000X for biological specimens)• Allows scientists to view the finest structure of cells. **Transmission Electron Microscope - TEM** (up to 100,000X)• Often used to view structures of cells and viruses • Electrons are transmitted through the specimen• The specimen must be very thin (20-100 nm thick) and stained to increase image contrast• dark areas of a TEM image represent thicker or denser parts TEM of HIV virus. **Scanning Electron Microscope - SEM (up to 650,000X)** • Creates an extremely detailed three-dimensional view of all kinds of objects• Electrons bombard the surface of a whole metal-coated specimen• Electrons deflected from the surface are picked up by a sophisticated detector• The electron pattern is displayed as an image on a television screen• Contours of specimens resolved with SEM are very revealing and surprising• The images may be computer enhances to give them color. **Types of Extremophiles** : Some types of microbes are extremophiles, meaning they thrive in extreme conditions that would quickly kill many other organisms. Some examples of extreme environments where microbes have been found are hot springs, saline lakes, the ocean floor, deep-sea hydrothermal vents, acid mine drainage sites, cold deserts, and subglacial lakes. While many extremophiles are either archaea or bacteria, there are also some extremophilic eukaryotes. Extremophiles come in many different varieties: **Acidophiles** and **alkaliphiles** prefer to live in areas with very low (usually pH < 3) or very high pH (usually pH > 9), respectively. In contrast, neutrophiles prefer environments around pH = 7 and are not considered extremophiles. **Capnophiles** inhabit environments with very high concentrations of carbon dioxide (CO_2). **Halophiles** are highly tolerant to environments with high salt concentrations, such as salt lakes. **Osmophiles** are organisms that live in areas with very high osmotic pressures, which result from high concentrations of solutes - especially sugars - in the surrounding environment. **Piezophiles** (also called barophiles) live under conditions of high hydrostatic pressure.



Thermophiles are microorganisms prefer very high temperature environments. Usually, thermophiles are considered to live between 45-80C (sometimes the lower end of the range is states as closer to 50C), and organisms that grow best above 80C are called hyperthermophiles. **Psychrophiles** (also called cryophiles) are extremophilic organisms that grow at temperatures -20C to 20C, while mesophiles usually reside in moderate temperatures between 20-45C and are not considered extremophiles. **Xerophiles** are a type of extremophile that inhabit environments with very low moisture or humidity. Other extremophiles are capable of dealing with high concentrations of gases that are toxic to many other microbes. Some extremophiles exhibit metallotolerance, the ability to live in conditions with high concentrations of metal cations, and are called metallophiles. Some extremophiles exhibit radioresistance, the ability to withstand very high doses of ionizing and/or nuclear radiation, and are called **radiophiles** (e.g., Deinococcus radiodurans, and a group of microscopic animals called Tardigrades). In many cases, extreme environments have more than one extreme quality and are inhabited by polyextremophiles, which are organisms that display multiple tolerances to extreme conditions.