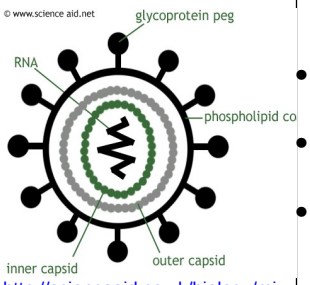
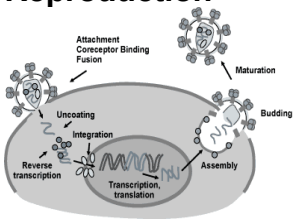
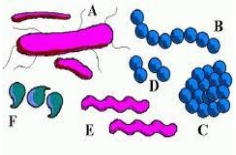
CHARACTERISTICS	VIRUSES
Basic, general structure  http://scienceaid.co.uk/biology/micro/viral.html	• Very small: 20 to 450 nm; shapes can vary – round, pointy, helical • Pieces of DNA or RNA are wrapped in a symmetrical protein sheath called a capsid. The capsid is made up of sub-units called capsomeres. The protein coat protects the nucleic acid from nuclease enzymes in the host cell. • Some viruses have 1 or 2 specific enzymes that are important for replication in the host cell. • Some viruses that infect animal cells have an envelope made from lipoproteins (that originate from the cell membrane of the host). • Bacteriophages are viruses that specifically infect bacterial cells – their structure differs slightly from the traditional virus. Bacteriophages tend to inject their DNA into the bacterial cell, leaving its capsid on the outside of the bacterial cell. • Any kind of organism (except mosses?) can be infected by a virus.
Prokaryote or Eukaryote	• Neither. • Viruses only contain fragments of DNA or RNA which may be linear, circular, single stranded or double stranded – this is the template for the production of new viral nucleic acids and proteins.
Uni- or multicellular	Acellular. Viral particles not called viral cells, but virions.
Cell walls	None.
Nutrition	None. They have no metabolism and therefore do not need energy.
Symbiotic relationships	Polydna viruses - The full genome of this virus is integrated into the genome of the specific wasp and the virus only replicates in the ovaries of the female wasp. The virus is injected along with the wasp egg into the body cavity of a host caterpillar and infects cells of the caterpillar. Without the virus infection blood cells will encapsulate and kill the wasp egg, but the immune suppression caused by the virus allows for hatching and complete development of the immature wasp in the caterpillar.
Reproduction  *http://www.clinicaloptions.com/~/media/InPractice/HIV/Ch%2010%20Overview%20of%20ARV/Overview_of_ARVs_Figure2.ashx*	• This can only take place inside a host cell. • Viruses connect to a receptor on the host cell's surface and by either fusing with the cell membrane or endocytosis the virus enters the host's cell. • The envelope is lost, the protein capsid is broken down and the RNA or DNA is released in the cytoplasm. • The host's DNA is used to produce the components of new virions (enzymes so that the viral genome can be replicated as well as proteins for the new capsids). • New viral particles assemble themselves to form virions and then leave the cell.
Positive effect or role in environment / symbiotic relationships or economic uses	• Viruses can be used in vaccinations (live but weakened viruses for MMR or flu, or inactivated viruses against hepatitis or polio) • It can be used in gene therapy to bring genetic material into cells to compensate for an abnormal/mutated gene or to make a beneficial protein. • Viruses can target and kill selected cell populations like rapidly dividing cancer cells, e.g. liver and cervical cancer. • Bacteriophages can be used as pesticides in agriculture targeting e.g. the bacteria that cause tomato spot. • It can be used for the production of proteins for industrial and research purposes.
Negative effect or diseases	Influenza, AIDS, herpes, polio, common cold, chicken pox, measles, mumps, and rubella.

CHARACTERISTICS	BACTERIA
Basic, general structure	• They come in various shapes: rods (bacilli), spherical (cocci), spiral (spirilla) or comma shaped (vibrio), can have one or more flagella for movement. • Bacteria are present in air, water, plants, animals, even in hot springs and at a very low pH (Achaea) • All bacteria have a cell wall, cell membrane, cytoplasm, a single chromosome and ribosomes. • Some have a capsule on the outside of the cell wall (for protection and to stick together), flagella (hair like appendages for movement in liquids) and endospores (that make them resistant to harsh conditions). • Bacteria carry out respiration although they do not have mitochondria.
Pro- or Eukaryote	• Prokaryotes - they lack a true nucleus (genetic material included in a nucleus with a membrane) • All bacteria contain a single circular chromosome.
Uni- or multicellular	• Always unicellular. • Coccus and Bacillus bacteria species often form colonies, e.g. diplococcic species (2 together), streptococci (cells in a chain) and staphylococci (mass of cells).
Cell walls  	• The cell wall gives the cell its particular shape. • Prokaryote cell walls are unique – it contains a complex polymer known as peptidoglycan. • Two types of bacteria, Gram positive and Gram negative. Differences in cell wall structures make one type keep the gram stain and the other not. Gram + or - is important especially for diagnosing diseases. • The chemical composition of the cell wall plays an important role in the vulnerability to antibiotics.
Nutrition	• Most bacteria are heterotrophs, feeding on dead organic matter. • Some bacteria are photoautotrophs, e.g. the *Cyanobacteria* that contains chlorophyll (close to the cell membrane, not in chloroplasts) • Some are chemoautotrophs that can e.g. convert ammonia and ammonium into nitrites and nitrates which plants can use. • Others are parasites that live in association with other living organisms.
Symbiotic relationships  http://schaechter.asmblog.org/schaechter/2007/08/e-coli-in-good-.html	• *Escherichia coli* are normal inhabitants of the intestines of all animals, including humans. They are straight, rod-shaped, Gram-negative bacteria which normally serve a useful function in the body by suppressing the growth of harmful bacterial species and by synthesising vitamin K and B. • Ruminants like cows and buck rely on bacteria in their stomachs to break cellulose down. (Cellulose gives rigidity to the cells; the bonds between cellulose molecules are very strong). • In the Legume family are plants like peanuts, soybean, clover and rooibos that have symbiotic nitrogen fixing bacteria, called *Rhizobium*, within nodules in their root systems. These bacteria chemically convert the nitrogen from the air and make it available for the plant.
Reproduction	• Mostly takes place asexually through a process called binary fission (“in two, splitting”) • A type of sexual reproduction can occur. (The nuclei never completely fuse but genetic information is passed from one bacterium to another, resulting in genetic recombination). • Some species are able to form spores (endospores) in unfavourable conditions (heat, freezing, extreme pH, chemicals, and dehydration) which enable them to become dormant/resting. When favourable conditions return the spores germinate to form a new cell again.
Positive effect or role in environment / or economic uses	• Decomposition of organic matter in the soil, maintaining soil fertility. • Clearing the environment by breaking down organic compounds e.g. dead plant material and animal carcasses. • Fermentation of milk to form yogurt and cheese where bacteria ferment/ break down sugars to form lactic acid which sours the milk and hinders the growth of pathogenic bacteria. • Genetic engineering can put a human gene (e.g. the gene responsible for producing insulin) inside bacteria which then reproduce fast under suitable conditions so that a lot of insulin is produced in a short time. • Production of antibiotics e.g. streptomycin and tetracycline

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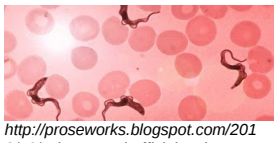
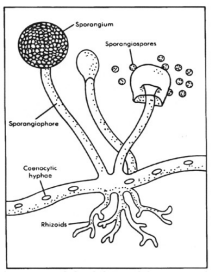
	• Production of certain plastics, ethanol and other chemicals • During sewage treatment bacteria break down the material into acids, carbon dioxide and methane.
Negative effect or diseases	• Bacteria cause diseases such as cholera, tuberculosis, tetanus, bacterial pneumonia, bacterial meningitis, even tooth decay. In plants bacteria can cause blight, rust, leaf spot, ect.

CHARACTERISTICS	PROTISTA
Basic, general structure	• This kingdom has a diverse group of organisms that are all eukaryotes, which cannot be classified as fungi, plants or animals. • They vary hugely in size – some are microscopic, others as large as trees (brown plant-like kelp). • Many are free-living with flagella for movement (*Euglena*); some have cilia or move with pseudopodia. Others have none of these. Still others are sessile and attach themselves to e.g. rocks under the water.
Prokaryote or Eukaryote	Eukaryotes – all protists have a proper membrane bound nucleus.
Uni- or multicellular	Very diverse. Protists include single-celled organisms like *Chlamydomonas*, colonial forms e.g. *Volvox* (made up of 500 – 60 000 individuals) of multi-cellular organisms such as *Spirogyra* and sea weeds.
Cell walls	On the outside of the cell membrane different protists can have different material to form cell walls – pectin, silica or cellulose.
Nutrition	Some like the green, brown and red algae are autotrophs which photosynthesise; others like the protozoa are heterotrophs (*Amoeba* and the slime moulds that look like fungi), or parasites that cause diseases (*Plasmodium, Trypanosoma*).
Symbiotic relationships  ***Paramecium*** *http://protist.i.hosei.ac.jp/pdb/images/ciliophora/paramecium/bursaria/sp_10.html*	• Protozoa living in the intestines of termites digest the wood eaten by the termites • The common freshwater ciliate *Paramecium bursaria* is an example of endosymbiosis by protists. Green alge/endosymbionts fix carbon through photosynthesis while the host provides nitrogen compounds. (Endosymbiosis takes place in many aquatic multicellular organisms that live in symbioses with photosynthetic algae - well-known examples are corals and sponges).
Reproduction	• Algae divide asexually, rarely sexually. • Protozoa divide asexually via binary fission, sometimes sexually by conjugation (exchange of nuclei) or by the production and fusion of gametes. • Many protists can survive harsh conditions by forming cysts (dormant forms of a cell with resistant outer coverings in which very little metabolism occur).
Positive effect or role in environment / or economic uses	• In aquatic ecosystems algae release oxygen and produce food during photosynthesis. • Extracts from seaweeds are used for agar, plant growth hormones, mineral salt tablets, iodine, in cosmetics, paints, medicine and salad dressings. • Diatomes with their silica cell walls form sediment - this fine clay is used for

	paper, paint and as filters in some swimming pools.
Negative effect or diseases  *http://proseworks.blogspot.com/2012/10/science-and-official-style-unusual-match.html*	• Malaria is caused by a protist-parasite belonging to the *Plasmodium* group (the *Anopheles* mosquito is the second host), • *Trypanosoma* causes sleeping sickness. The protists are not killed by the immune system because it has a glycoprotein (VSG) coating.

CHARACTERISTICS	FUNGI
Basic, general structure  *http://www.cartage.org.lb/en/themes/sciences/lifescience/generalbiology/microbiology/Fungi/Classification/Classification.htm*	• All fungi develop from spores and no fungi display flagella, cilia, or chloroplasts. • Many fungi are made of thread-like filaments called hyphae. Rhizoids are root-like parts of hyphae that anchor the fungus to the substrate; the stolons are the hyphae that grow over the substrate, whereas the sporangiophores stand up straight and carry the sporangia. • The whole tangled, intertwining mass of hyphae are called the mycelium**.** Mycelium increases the surface area of the fungi to absorb more nutrients. • Fungal mycelium is mostly hidden from human view because it is usually hidden deep within its food source (such as rotting matter in the soil, leaf litter, rotting wood, or dead animals). • The mycelium remains undetected until it develops one or more fruiting bodies, containing the reproductive spores. The fruiting bodies are carried at the surface of the food source (not hidden within the substrate) and allows for spores to be shed and carried away by wind, water or animals.
Prokaryote or Eukaryote	• Eykaryote – DNA is enclosed in a double membrane to form a nucleus • Some multi-nucleated, non septated species are said to be coenocytic (Greek “koinos” meaning shared , and “kytos” a vessel)
Uni- or multicellular	• Some are unicellular (e.g. yeast) but most are multi-cellular.
Cell walls	• Most species have cell walls from chitin, a minority has cell walls from cellulose. • Each hyphae is one continuous cell, but they may have septae/ cross-walls that divide the cytoplasm, or the cross-walls may be perforated, or the cross-walls may be absent (*Rhizopus, Mucor*).
Nutrition	• Most fungi are saprophytic heterotrophs that live on dead organic matter. Some are parasitic. • Saprophytic fungi use digestive enzymes to break down their food outside their bodies, they then absorb the digested food. • Some fungi live in a mutualistic relationship with other organisms, e.g lichens • Predaceous fungi specialise to capture microscopically small animals - they can secrete a sticky substance on the hyphae, or form a loop that swells and strangle e.g. round worms.
Symbiotic relationships	• In lichens a fungus and a green algae or cyanobacterium co-exists. The algae produce organic food via photosynthesise, whereas the fungus supplies the inorganic nutrients. • Mycorrhizae are mutually beneficial associations between plant roots, e.g fynbos plants in nutrient poor soils, and fungi. Fungus hyphae help in water and mineral uptake for the plant and in doing so increase plant growth, while the plant roots secrete a substance that the fungus need. • Some fungi form mutualistic relationships with ants - ants actively spread, nurture and defend the fungus; the fungus provides nutrients for the ants in return.
Reproduction	• Fungi produce spores in both asexual and sexual life cycles. • Mushrooms let out spores from their gills that are carried by the wind to meet other spores and become a new fungus. • Yeast are unicellular and divide into new fungal cells (mitosis)
Positive effect or role in environment / or economic uses	• Saprophyte fungi are essential decomposers that use non-living organic material. This is important in recycling carbon, nitrogen and essential mineral nutrients • Breaking down of rocks into soil. • Used as food for humans and animals (e.g mushrooms, truffels) • Used in bread, beer, cheese (Camembert, Roquefort)and wine making • Yeasts – baking and brewing beer • Antibiotics – penicillin & cephalosporin • Production of organic acids – citric acid in Coke • Steroids and medicines – birth control pills

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Negative effect or diseases	• Diseases like ringworm, athlete's foot, thrush in humans • Parasitic fungi cause 80% of plant diseases, e.g. powdery mildew on fruit, ergot parasite in rye, rusts in plants