Identify mechanisms of action of antimicrobial agents biology essay

Science, Biology

Clinical microbiologySection 2: microbial monitoring

Identify mechanisms of action of antimicrobial agents.

Describe a range of physical and chemical treatments to control microorganisms.

An antimicrobial agent is a chemical that kills or inhibits the growth of microorganisms such as bacteria, fungi and protozoans. Antimicrobial agents are used to kill or stop the growth of microorganisms which could infect people/animals/crops, and are very important in medical and laboratory procedures. There are many types of antimicrobial agents, such as: AntibioticsAntiviral drugsAntifungalsAntihelminthic drugsThere are also a number of chemical agents which limit microbial growth: AntisepticsGermicidesSanitizersDisinfectantsSterilisersAntimicrobial agents are used to kill or inhibit the growth of microorganisms, and they are relatively harmless to the host, therefore can be used to treat infections. Antibiotics are used to treat infections caused by bacteria, they are chemicals produced by a microorganism that kills or inhibits the growth of another microorganism. The very first antibiotics were natural products, however over time these natural molecules have been modified. Several types of semi-synthetic antibiotics have been derived from these molecules. No antibiotic is effective against all microbes. The original natural molecules used as antibiotics had a very narrow spectrum – meaning that they only acted on a few microorganisms, but with modern chemical modifications it is possible to broaden their spectrum. Antibiotics are classified as either broad-spectrum or narrow-spectrum. Normally a single antibiotic is used to treat an infection, however a combination of antibiotics may be used when patients have a mixed infection (more than one type of bacteria) or a life-threatening infection. The way antibiotics work is by targeting a specific part or process in the bacteria and inhibiting the growth/activity of that bacterium. The antibiotic targets are sub-divided into: Cell Wall: provides the bacteria with outer protection, and mediates the amount of liquid that can enter and leave the cell. Cell Membrane: is a lipid bilayer and functions as a permeability barrier. Cellular Proteins: these targets can include ribosomes and other proteins vital for cell metabolism and reproduction. Cellular Nucleic Acids: interfere with DNA production. Many antibiotics, antifungals, and antivirals act on the DNA or RNA of a cell. Gene function may be suppressed by inhibiting nucleic acid or protein synthesis. Enzyme Inhibition: irreversible or reversible binding or competitive inhibition of cell enzymes. Figure 1 shows the common antibiotic targets and resistance: Antibiotic targets and mechanisms of antibiotic resistanceThe cell wall is the most appealing target for antibiotics. It is found in both Gram-positive and Gram-negative bacteria. The plasma membrane is involved with important physiological functions, so is a prime target for antibiotics as any disruption of the membrane destroys the bacteria. Antibiotics act at different sites on bacterial ribosomes – the sites for protein synthesis. DNA and RNA are universal components which can be attacked by antibiotics. Antibiotics can be tested to evaluate how effective they are against a certain bacteria. The most widely used test for this is the Kirby-Bauer test; where an agar plate is covered with a known pathogen and filter-paper disks are impregnated with known concentrations of the antibiotic compound. They are placed on the agar and left to incubate. The zones of inhibition show how effective the antibiotic is. This method is also used to compare the relative effectiveness of different compounds. Figure 2 shows a Kirby-Bauer test: http://www. cdc. gov/meningitis/lab-manual/images/chapt11-figure01. gifAntibiotics are very effective and widely used in the treatment of bacterial infections; however bacteria can become resistant to antibiotics. Antibiotic resistance is a relative or complete lack of effect of an antibiotic against a previously susceptible microbe. Bacteria are constantly finding ways to counteract antibiotics. One of the most important bacterial defence mechanisms is the production of β-lactamase, which makes them resistant to penicillin. One way to overcome penicillin resistance is to combine penicillin drug with a molecule that protects the penicillin. Bacterial resistance to an antimicrobial agent may be due to some innate property of the organism or it may due to acquisition of some genetic trait as described below. Inherent (Natural) Resistance - Bacteria may be inherently resistant to an antibiotic. For example, a streptomycete may have some natural gene that is responsible for resistance to its own antibiotic; or a Gram-negative bacterium has an outer membrane that establishes a permeability barrier against the antibiotic; or an organism lacks a transport system for the antibiotic; or it lacks the target or reaction that is hit by the antibiotic. Acquired Resistance - Bacteria can develop resistance to antibiotics, e. g. bacterial populations' previously-sensitive to antibiotics become resistant. This type of resistance results from changes in the bacterial genome. Acquired resistance is driven by two genetic processes in bacteria: mutation and selection (sometimes referred to as vertical evolution) and exchange of genes between strains and species (sometimes called horizontal evolution or horizontal gene transmission). Factors that promote antimicrobial resistance are: exposure to sub-optimal levels of antimicrobial; exposure to microbes carrying a resistance gene; inappropriate antimicrobial use, for example prescriptions not taken properly, or spread of resistant microbes in hospitals due to lack of hygiene. The consequences of antimicrobial resistance are infections resistant to available antibiotics – so more people may be susceptible to infections, and those with severe infections could die from it, also there will be an increased cost of treatment as people will become more severely ill and may need hospitalization, and there will be increased pressure to find a new antimicrobial drug. Antiviral drugs are specific to treating viral infections. Viruses live inside host cells and use many host enzymes. How a virus infects a host is crucial to understanding how infections begin after individual virus particles infiltrate the host's cells. This can be accomplished because viruses are so tiny that they may slip through cellular defences unopposed. Once inside a host cell, a virus moves to the cell's nucleus where all the DNA and RNA functions as instructions for the cell's operation. By inserting its own genetic information into the cell's nucleus a virus can hijack its function, causing it to produce and release more virus particles so the infection spreads. Another common effect of this cellular hijacking is the damage, breakdown and eventual death of the cell itself. Like most drugs used to treat infectious pathogens, antivirals are targeted to specific strains of viruses and work in a variety of ways. Most antiviral drugs don't actually kill the virus particles themselves as inhibit their reproduction. Since viruses cannot reproduce without infecting a host cell antiviral drugs have been designed to interfere with the infection process. This interference may be

achieved in numerous ways, including blocking the virus from the host cell, preventing the virus from releasing its genetic material once it reaches the nucleus and preventing the virus's genetic data from being spliced into the host cell's DNA. Various highly specific antiviral drugs have also been developed that target the enzymes and proteins that an infected host cell uses to assemble new virus particles and prevent them from functioning correctly. Such drugs must be designed very carefully so that they do not interfere with the metabolism of healthy cells. A final type of antiviral drug targets the virus indirectly, by increasing the efficiency with which the host's immune system can fight the viral infection. Antifungal drugs work by either killing the fungal cells or inhibiting their growth. Antifungal medicines are used in several ways, depending on your specific fungal infection. The main types of antifungal medicines include: topical antifungals, applied to the skin, hair or nails; oral antifungals, swallowed in capsule, pill or liquid form; intravenous antifungals, injected into your bloodstream. Antihelminthic drugs are drugs that expel parasitic worms (helminths) from the body, either by stunning them, or killing them. They may also be
called vermifuges (stunning) or vermicides (killing). Helminths are macroscopic multicellular eukaryotic organisms such as: tapeworms, roundworms, pinworms and hookworms.

Explain the terms sterilisation, disinfection and asepsis.

Sterilisation: Sterilisation is a process that kills all forms of microbial life present on a surface, in a fluid, in medication or in compounds such as a culture medium. Sterilisation is achieved by applying the proper combinations of chemicals, heat, high pressure, radiation and filtration. Using heat is the most effective method of sterilisation. Disinfection: A disinfectant is a chemical or physical agent that is applied to non-living objects to kill microorganisms; however it does not necessarily destroy all types of microorganism. It is not as effective as sterilisation, which is more extreme. Disinfectants are used daily in hospitals, dentists, and homes to kill pathogens. Asepsis: Asepsis is defined as the absence or exclusion of bacteria, viruses, and other microorganisms. Aseptic techniques are used to perform procedures (including medical and laboratory techniques) under sterile conditions. Aseptic techniques aim to reduce the risk of contamination or infection. In microbiological techniques, in order to obtain accurate results, all equipment must be sterilised. Aseptic techniques are important to use because they reduce the likelihood of contamination of the culture. Aseptic techniques protect the bacterial culture plate, but also protect the person working with/handling microorganisms from cross contamination. If we did not use aseptic techniques, people working with microorganisms would be frequently exposed to potentially harmful bacteria/organisms and the results obtained from experiments in the lab would be inaccurate due to contamination.

Differentiate ‘ bactericidal’ and ‘ bacteriostatic’ treatments.