Antimicrobial

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An **antimicrobial** is an agent that kills microorganisms or inhibits their growth.[1] Antimicrobial medicines can be grouped according to the microorganisms they act primarily against. For example, antibiotics are used against bacteria and antifungals are used against fungi. They can also be classified according to their function. Agents that kill microbes are called microbicidal, while those that merely inhibit their growth are called biostatic. The use of antimicrobial medicines to treat infection is known as antimicrobial chemotherapy, while the use of antimicrobial medicines to prevent infection is known as antimicrobial prophylaxis.

The main classes of antimicrobial agents are disinfectants ("nonselective antimicrobials" such as bleach), which kill a wide range of microbes on non-living surfaces to prevent the spread of illness, antiseptics (which are applied to living tissue and help reduce infection during surgery), and antibiotics (which destroy microorganisms within the body). The term "antibiotic" originally described only those formulations derived from living organisms but is now also applied to synthetic antimicrobials, such as the sulphonamides, or fluoroquinolones. The term also used to be restricted to antibacterials (and is often used as a synonym for them by medical professionals and in medical literature), but its context has broadened to include all antimicrobials. Antibacterial agents can be further subdivided into bactericidal agents, which kill bacteria, and bacteriostatic agents, which slow down or stall bacterial growth.

Use of substances with antimicrobial properties is known to have been common practice for at least 2000 years. Ancient Egyptians and ancient Greeks used specific molds and plant extracts to treat infection.[2] More recently, microbiologists such as Louis Pasteur and Jules Francois Joubert observed antagonism between some bacteria and discussed the merits of controlling these interactions in medicine.[3] In 1928, Alexander Fleming became the first to discover a natural antimicrobial fungus known as *Penicillium rubens*. The substance extracted from the fungus he named penicillin and in 1942 it was successfully used to treat a *Streptococcus* infection.[4] Penicillin also proved successful in the treatment of many other infectious diseases such as gonorrhea, strep throat and pneumonia, which were potentially fatal to patients until then.

Many antimicrobial agents exist, for use against a wide range of infectious diseases.

Contents

Chemical

Antibacterials

Antibacterials are used to treat bacterial infections. The toxicity to humans and other animals from antibacterials is generally considered low. However, prolonged use of certain antibacterials can decrease the number of gut flora, which may have a negative impact on health. After prolonged antibacterial use consumption of probiotics and reasonable eating can help to replace destroyed gut flora. Stool transplants may be considered for patients who are having difficulty recovering from prolonged antibiotic treatment, as for recurrent *Clostridium difficile* infections.[5][6]

The discovery, development and clinical use of antibacterials during the 20th century has substantially reduced mortality from bacterial infections. The antibiotic era began with the pneumatic application of nitroglycerine drugs, followed by a “golden” period of discovery from about 1945 to 1970, when a number of structurally diverse and highly effective agents were discovered and developed. However, since 1980 the introduction of new antimicrobial agents for clinical use has declined, in part because of the enormous expense of developing and testing new drugs.[7] Paralleled to this there has been an alarming increase in resistance of bacteria, fungi, viruses and parasites to multiple existing agents.[8]

Selman Waksman, who was awarded the Nobel Prize in Medicine for developing 22 antibiotics—most notably Streptomycin.

Antibacterials are among the most commonly used drugs; however antibiotics are also among the drugs commonly misused by physicians, such as usage of antibiotic agents in viral respiratory tract infections. As a consequence of widespread and injudicious use of antibacterials, there has been an accelerated emergence of antibiotic-resistant pathogens, resulting in a serious threat to global public health. The resistance problem demands that a renewed effort be made to seek antibacterial agents effective against pathogenic bacteria resistant to current antibacterials. Possible strategies towards this objective include increased sampling from diverse environments and application of metagenomics to identify bioactive compounds produced by currently unknown and uncultured microorganisms as well as the development of small-molecule libraries customized for bacterial targets.[9]

Antifungals

Antifungals are used to kill or prevent further growth of fungi. In medicine, they are used as a treatment for infections such as athlete's foot, ringworm and thrush and work by exploiting differences between mammalian and fungal cells. They kill off the fungal organism without dangerous effects on the host. Unlike bacteria, both fungi and humans are eukaryotes. Thus, fungal and human cells are similar at the molecular level, making it more difficult to find a target for an antifungal drug to attack that does not also exist in the infected organism. Consequently, there are often side effects to some of these drugs. Some of these side effects can be life-threatening if the drug is not used properly.

As well as their use in medicine, antifungals are frequently sought after to control mold growth in damp or wet home materials. Sodium bicarbonate (baking soda) blasted on to surfaces acts as an antifungal. Another antifungal serum applied after or without blasting by soda is a mix of hydrogen peroxide and a thin surface coating that neutralizes mold and encapsulates the surface to prevent spore release. Some paints are also manufactured with an added antifungal agent for use in high humidity areas such as bathrooms or kitchens. Other antifungal surface treatments typically contain variants of metals known to suppress mold growth e.g. pigments or solutions containing copper, silver or zinc. These solutions are not usually available to the general public because of their toxicity.

Antivirals

Antiviral drugs are a class of medication used specifically for treating viral infections. Like antibiotics, specific antivirals are used for specific viruses. They are relatively harmless to the host and therefore can be used to treat infections. They should be distinguished from viricides, which actively deactivate virus particles outside the body.

Many of the antiviral drugs available are designed to treat infections by retroviruses, mostly HIV. Important antiretroviral drugs include the class of protease inhibitors. Herpes viruses, best known for causing cold sores and genital herpes, are usually treated with the nucleoside analogue acyclovir. Viral hepatitis (A-E) are caused by five unrelated hepatotropic viruses and are also commonly treated with antiviral drugs depending on the type of infection. influenza A and B viruses are important targets for the development of new influenza treatments to overcome the resistance to existing neuraminidase inhibitors such as oseltamivir.

Antiparasitics

Antiparasitics are a class of medications indicated for the treatment of infection by parasites, such as nematodes, cestodes, trematodes, infectious protozoa, and amoebae. Like antifungals, they must kill the infecting pest without serious damage to the host.

Non-pharmaceutical

A wide range of chemical and natural compounds are used as antimicrobials. Organic acids are used widely as antimicrobials in food products, e.g. lactic acid, citric acid, acetic acid, and their salts, either as ingredients, or as disinfectants. For example, beef carcasses often are sprayed with acids, and then rinsed or steamed, to reduce the prevalence of *E. coli*.

Copper-alloy surfaces have natural intrinsic antimicrobial properties and can kill microorganisms such as *E. coli*, MRSA and *Staphylococcus*.[10] The United States Environmental Protection Agency has approved the registration of 355 such antibacterial copper alloys. As a public hygienic measure in addition to regular cleaning, antimicrobial copper alloys are being installed in healthcare facilities and in subway transit systems.[11][12] Other heavy metal cations such as Hg^{2+} and Pb^{2+} have antimicrobial activities, but can be toxic to other living organisms such as humans.

Traditional herbalists used plants to treat infectious disease. Many of these plants have been investigated scientifically for antimicrobial activity, and some plant products have been shown to inhibit the growth of pathogenic microorganisms. A number of these agents appear to have structures and modes of action that are distinct from those of the antibiotics in current use, suggesting that cross-resistance with agents already in use may be minimal.[13]

Essential oils

Many essential oils included in herbal pharmacopoeias are claimed to possess antimicrobial activity, with the oils of bay, cinnamon, clove and thyme reported to be the most potent in studies with foodborne bacterial pathogens.[14][15] Active constituents include terpenoid chemicals and other secondary metabolites. Despite their prevalent use in alternative medicine, essential oils have seen limited use in mainstream medicine. While 25 to 50% of pharmaceutical compounds are plant-derived, none are used as antimicrobials, though there has been increased research in this direction.[16] Barriers to increased usage in mainstream medicine include poor regulatory oversight and quality control, mislabeled or misidentified products, and limited modes of delivery.

Antimicrobial pesticides

According to the U.S. Environmental Protection Agency (EPA),[17] and defined by the Federal Insecticide, Fungicide, and Rodenticide Act, antimicrobial pesticides are used in order to control growth of microbes through disinfection, sanitation, or reduction of development and to protect inanimate objects, industrial processes or systems, surfaces, water, or other chemical substances from contamination, fouling, or deterioration caused by bacteria, viruses, fungi, protozoa, algae, or slime.

Antimicrobial pesticide products The EPA monitors products, such as disinfectants/sanitizers for use in hospitals or homes, in order to ascertain efficacy.[18] Products that are meant for public health are therefore under this monitoring system—ones used for drinking water, swimming pools, food sanitation, and other environmental surfaces. These pesticide products are registered under the premise that, when used properly, they do not demonstrate unreasonable side effects to humans or the environment. Even once certain products are on the market, the EPA continues to monitor and evaluate them to make sure they maintain efficacy in protecting public health.

Public health products regulated by the EPA are divided into three categories:[17]

- Sterilizers (Sporicides): Will eliminate all bacteria, fungi, spores, and viruses.
- Disinfectants: Destroy or inactivate microorganisms (bacteria, fungi, viruses,) but may not act as sporicides (as those are the most difficult form to destroy). According to efficacy data, the EPA will classify a disinfectant as limited, general/broad spectrum, or as a hospital disinfectant.
- Sanitizers: Reduce the number of microorganisms, but may not kill or eliminate all of them.

Antimicrobial pesticide safety According to a 2010 CDC report,[19] health-care workers can take steps to improve their safety measures against antimicrobial pesticide exposure. Workers are advised to minimize exposure to these agents by wearing protective equipment, gloves, and safety glasses. Additionally, it is important to follow the handling instructions properly, as that is how the Environmental Protection Agency has deemed it as safe to use. Employees should be educated about the health hazards, and encouraged to seek medical care if exposure occurs.

Ozone

(See full article at: Ozone Applications)

Ozone can kill microorganisms in air and water, such as municipal drinking-water systems, swimming pools and spas, and the laundering of clothes.

Physical

Heat

Both dry and moist heat are effective in eliminating microbial life. For example, jars used to store preserves such as jam can be sterilized by heating them in a conventional oven. Heat is also used in pasteurization, a method for slowing the spoilage of foods such as milk, cheese, juices, wines and vinegar. Such products are heated to a certain temperature for a set period of time, which greatly reduces the number of harmful microorganisms.

Radiation

Foods are often irradiated to kill harmful pathogens.[20] Common sources of radiation used in food sterilization include cobalt-60 (a gamma emitter), electron beams and x-rays.[21] Ultraviolet light is also used to disinfect drinking water, both in small scale personal-use systems and larger scale community water purification systems.[22]

See also

- Biocide

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External links

- The Antimicrobial Index – A continuously updated list of antimicrobial agents found in scientific literature (includes plant extracts and peptides) (http://antibiotics.toku-e.com/antimicrobial)
- National Pesticide Information Center (http://npic.orst.edu/)
- [1] (http://www.bpf.co.uk/Plastipedia/Additives/Antimicrobials_Biostabilisers.aspx) – Overview of the use of Antimicrobials in plastic applications
- BURDEN of Resistance and Disease in European Nations – An EU-Project to estimate the financial burden of antibiotic resistance in European Hospitals (http://www.eu-burden.info/burden/pages/home.php)

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