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|  | Due to the fact that bacteria are becoming more and more immune to antibiotics, this experiment is designed to evaluate the antibacterial properties of plants within the genus Allium, in the hope of finding an effective herbal alternative to antibiotics.  The End of Antibiotics?  Over seventy years ago, one of the first antibiotics was discovered oozing out of mold in a laboratory dish. Sir Alexander Fleming had been experimenting with Staphyloccus bacteria when he observed a bacteria-free circle around a mold growth of Penicillium notatum spores. Upon investigation, he found a substance in the mold which prevented the growth of bacteria even when diluted up to eight hundred times! This antibacterial agent, as Alexander Fleming called it, was penicillin. Fleming's discovery earned him the Nobel Prize for Physiology or Medicine in 1945, and paved a path for further antibiotic therapy for infectious diseases.  Such discoveries, however, have begun a race between man and the microbe. In 1946, just five years after penicillin was in wide use, due to World War II, doctors began to discover that the bacteria Staphyloccus was invulnerable to penicillin. Solution to the problem: invent new antibiotics. Once again, drugs controlled the microbes. Within time, though, the bacteria regrouped and those capable of enduring the latest drugs appeared thus creating a continuous cycle. With new drugs evolve new "mutants". When a colony of bacteria is treated with penicillin, for example, a few microbes may survive. The mutants then reproduce, creating as many as about 17 million offspring in 24 hours. (Fisher, *The Plague Makers*)  Figure 1: bacteria's fight against antibiotics  Though drugs may keep a slight lead, bacteria such as tuberculosis, syphilis, and gonorrhea have constantly evolved. "The perception in the 1890's was that we had conquered almost every infectious disease...instead, medicine's purport triumph over infectious diseases has become an illusion" (Begley, 47). Today, every disease-causing bacterium resists at least one of over our 100-plus antibiotics, many resist all but one. Such circumstances have caused a steep financial cost for antibiotics to patients. If the first antibiotic prescription fails, the patient must try several others. Due to such discouragement, federal funds for antibacterial research has greatly decreased over the years. The United States Food and Drug Administration (FDA) research has diminished, also. In 1991, they approved only five new antibiotics; in 1993, only one. (Begley, 49) Remaining research, though, is trying to discover decoy molecules which can lure away bacteria's killer enzymes so that antibiotics can attack undetected.  In addition to mutant genes, bacteria have developed means of defending themselves against antibacterial agents. One example is to secrete an enzyme to dismember the attacking antibiotic. They can also change their cell walls so that antibiotics can't get in or alter the bacterium. Other bacteria, such as E. coli, simply pump out the drug. As bacteria have changed, other evolutionary changes have been observed in biological history. Through the use of plasmids, small rings to DNA, bacteria can exchange resistance for various antibiotics, thus bacteria is capable to be resistant to antibiotics which it hasn't even encountered yet. For example, E. coli developed resistance to the antibiotic tetracycline, but when tested against other new antibiotics, the bacteria had already resisted them. It was as if they had anticipated the confrontation of other drugs when they had resisted one.  Herbal Remedies --- The Mother of All Medicines  For thousands of years, food has been regarded as potent medicine. But in the last century, pharmaceutical drugs have taken over as magic bullets, making us forget much of our rich heritage in the medical uses of foods. The idea that foods have pharmacological properties that can be used to promote health often seems like folklore, decidedly deficient in the scientific proof required in the twentieth century. We shall not forget that all drugs of the past were substances with a particular therapeutic action extracted from plants. More and more current researchers find that foods and their individual constituents perform similar fashion to modern drugs - and sometimes better - without the dreaded side effects. For example: yogurt cures diarrhea more quickly than a standard antidiarrheal drug, and ginger surpasses Dramamine in suppressing motion sickness. (Wainwright, *Miracle Cure*)  The use of the herbs and medicinal plants as the first medicines is a universal phenomenon. Every culture on Earth, through written or oral tradition, has relied on the vast variety of natural chemistry found in healing plants for their therapeutic properties. One of the earliest Chinese herbal texts-- Shen Nong's Classic of Materia Medica dating from the first or second centuries A.D. -- listed 365 healing remedies, most of them plants but including a few minerals and animal extracts. The Greek physician Dioscorides, writing in the first century A.D., mentioned about 400 herbs. Today, the list of plants with known medicinal properties has been extended: about 5,800 in the Chinese Materia Medica, 2,500 in India, at least 800 regularly collected from the tropical forest of Africa, almost 300 currently detailed for the medical profession in Germany, and many thousands more known only to traditional healers in the more remote corners of the world. (McKenna, *Natural Alternatives to Antibiotics*)  Herbs may be defined as any plant that can be put to culinary or medicinal use and include those we associate with orthodox drugs, such as foxglove and opium poppy, as well as everyday plants, such as garlic. Natural herbs have two advantages that surpass pharmaceutical drugs. First, many of them do not create any dreaded side effects, and second, it is much cheaper to copy nature in the laboratory than to harvest its benefits through extraction procedures. Today we can clearly see the results of such a perspective. In the inevitable cycle of nature, the progression of industry leads us right back to "natural" methods.  Garlic --- The Wonder Drug  Of all the herbs available for possible use as an herbal alternative to antibiotics, perhaps none shows such a degree of broad spectrum antibiotic activity as garlic. Garlic -Allium sativum- is a perennial with a bulb of 5-15 bulblets encased in a papery skin. It is thought to have originated in the high plains of west-central Asia and has been used medicinally for some 5,000 years. Despite the strong smell of garlic that many dislike, it is the "smelly part" of the garlic that kills "the bad things". Modern research has shown that garlic produces a by-product compound, allicin, created when the bulb is bruised or crushed. In the break-down process, an odorless, sulfur-containing amino acid, allicin, comes into contact with an enzyme, allinase, and produces a conversion to allicin. Allicin is the primary compound responsible for garlic's strong odor. Allicin, diallyl disulfide, diallyl trisulfide, ajoene (the combination of allicin and diallyl disulfide), and a number of additional compounds in garlic have all shown antibiotic activity. (Serrentine, *How Natural Remedies Work*) A number of studies have shown that garlic extracts, as well as individual components of garlic, have a broad antibiotic range, effective against both gram-negative and gram-positive bacteria. A 1983 study showed that garlic was effective against staphylococcus, streptococcus, cholera, diphtheria, typhus and shigella. A 1985 study reported in Scientific American states that "Laboratory investigations show that garlic juice diluted to one part in 125,000 inhibits the growth of bacteria." (Carper, *The Food Pharmacy*) Steven Foster reports in his monograph on garlic that a "1984 study by Singh and Shukla demonstrated that garlic shows promising activity against eight out of nine clinical strains of bacteria which are highly resistant to antibiotics." Of the nine antibiotic-resistant microbes, garlic would be effective against all except malaria. As demonstrated by Lam and Ng's experiment last year, garlic juice was effective in fighting against Bacillus cereus.  Genus Allium --- Mystical and Medicinal  According to the ancient Greek poet Homer, the magical properties of Allium moly allowed Ulysses to enter the lair of the sorceress, Circe, unharmed. Southern European folklore regards the plant as good luck and a protection against demons. Allium moly is an ornamental allium, or flowering onion. It is a close relative of the famous edible alliums: Allium sativum, (garlic) and Allium cepa (the common cooking onion). Garlic reportedly gave strength to the pyramid builders and courage to the Roman legions. Medicinally, it has served as a popular remedy for colds, sore throats and coughs; physicians and herbalists prescribed garlic as a diuretic and for intestinal disorders and rheumatism. In addition, people ate garlic daily as protection against plagues, creatures of darkness, and diseases. Early American colonists relied on the plant to treat a variety of medical problems, while later settlers strapped garlic cloves to the feet of smallpox victims, in hopes of curing them. Onions also have been used medicinally for centuries. In the Middle Ages the onion was used as a charm against evil spirits, the plague and infection. (Castleman, *The Healing Herbs*)The onion was a favorite spring food of American Indians, providing a frontiersman, with a good nose, a telltale means of locating an Indian encampment.  Man's long appreciation of alliums may just be beginning to pay dividends. Modern research has confirmed the medicinal values plants in this genus, such as garlic, onions, and chives. European homeopathic medics already use Allium ursinum, the Forest Onion, for that purpose. Flowering varieties too might have a contribution to make, for gardening is a recommended activity to help alleviate that most heinous of medical culprits: stress.  Allium is a large genus of about 700 species bulbous or rhizomatous biennials and perennials native to the northern hemisphere. Ethiopia, southern Africa, and Mexico, varying in hardiness according to origin. Various alliums have been cultivated since the earliest times and are universally important as vegetables, flavorings, and medicinal plants. The species in this genus are famous for their strong smell. Their distinctive smell also varies in pungency from species to species. In garlic, it has been proven that the part of the extract which create the strong smell contain antibacterial properties. (Serrentine, *How Natural Remedies Work*)We suspect, the relatives of garlic in this genus should somewhat has antibacterial factors. The four chosen relatives of garlic to be tested in this experiment are listed below.  Chives (Allium schoenoprasum)  Chives are a dwarfed onion relative with a delicate peppery taste in the lily family (Liliaceae). Clump-forming perennial with slender bulbs, they are a native of Northern Europe. Chives are an evergreen perennial with round, hollow leaves. It is believed that its sulfur compounds in them give them both their favor and their antibiotic properties. (Ody, *The Complete Medicianl Herbal*)  Shallot (Allium ascalonicum)  Shallot is the mildly aromatic herb of the lily family (Liliaceae) which are used to flavor food like onions, particularly meats and sauces. The shallot is a hardy, bulbous perennial that is closely related to onion and garlic and is probably of Asiatic origin. Its leaves are short, small, cylindrical, and hollow. The bulbs are small elongated, and angular and develop in clusters on a common base, much like a garlic plant. (Reader's Digest, *Family Guide to Natural Medicine*)  Onion (Allium Cepa)  Onion consists of its herbaceous plant part and its edible bulb part. It is probably a native to southwestern Asia. Onion and garlic are close cousins which are packed with similar therapeutic compounds. Pasteur is the first person to put onion to antibiotic test in the mid-1800's, and declared it antibacterial. Since then, onion and its essences have been proved to kill a long list of disease-causing bacteria. (Ody, *The Complete Medicianl Herbal*)  Leek (Allium porrum)  Leek is a hardy, vigorous, biennial plant. It is related to the onion and is widely used in European kitchen. It is native to eastern Mediterranean lands and the middle east, where it was cultivated in ancient times. The Romans probably brought it to Europe and the British Isles. The vegetable became the national emblem Wales following an ancient victory by an army of Welshmen who wore leeks as a distinguishing sign. (Ody, *The Complete Medicianl Herbal*)  Bacillus cereus  Bacillus cereus is a closely related bacterium to the antibacteria Bacillus anthracis, a sensitive bacterium known to be sensitive to garlic. In addition, Bacillus cereus is much less harmful that Bacillus anthracis. "Bacillus cereus is a gram-positive,...aerobic sporeformer" (http://vm.cfsan.ida.gov). It is contracted mainly from food poisoning. It is best known for causing both diarrhea and vomiting and possible nausea. These symptoms are usually shown within half to fifteen hours after consumption. The foods in which it is most likely to be found in is lamb, chicken, and starches (ie: rice, potato, pasta). It grows best from the temperatures of 25 degree C - 42 degree C. An infection of Bacillus cereus can not be transmitted from person to person. When one contracts the bacterium, it is advised to drink plenty of liquids. The following antibiotics are known to currently kill Bacillus cereus: aminoglycosides, chloramphenical, ciprofloxacin, erythromycin, elindamycinm, imipenem, and vanomying.  Antimicrobial Susceptibility Test  To test the effectiveness of the five substances (garlic, onion, chive, shallot, and leeks), we chose to use the antimicrobial susceptibility test. This test helps to determine whether the substance does or does not contain antibacterial properties. The most common method of the antimicrobial susceptibility test is the Bauer-Kirby Disc Diffusion. It consists of small round discs, such as chromatography paper, which are soaked in the chosen antibiotic and placed on a bacteria-rich agar plate, then kept overnight in an autoclave. This should produce zones of inhibition around each disc if it contains antibacterial properties. These zones can be measured and help determine whether the bacteria is susceptible or resistant to the antibacteria. Various factors may also affect the sizes of the zones of inhibition, such as humidity and the effectiveness of the agar solution. (Carter, *Investigating Biology*) |

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