**HL IB Biology: Socratic Seminars on Bioethics**

**1. Who Should Have Access to Genetic Information?**

In today’s marketplace, jobs are scarce and competition is intense. The questions that employers ask prospective employees are more extensive and personal than ever before. Many of today’s jobs require a considerable degree of precision and good judgment on the part of the employee, and training people to fill these jobs is expensive and time consuming. Employers use every means available to screen job applicants to uncover potential problems such as drug use, alcoholism or chronic illness. Any of these conditions can be cited as a reason for not hiring a person or for dismissing an employee. Employers have the right to know the capabilities of a person before they hire him or her, but how far do an employer’s rights go> should employers have the right to see a person’s genetic history?

**Genetic Advances in Predicative Technology**

At present, a technique is available that allows scientists to test the DNA of an unborn child for the presence of some hereditary disorders. Included among these disorders are muscular dystrophy, cystic fibrosis, Huntington disease, and Down syndrome. Having such knowledge is both a blessing and a burden for parents. It prevents the schock and agony of learning about the condition when the hild is born. The advance knowledge can help parents to prepare, both emotionally and financially, for having a disabled child. Some parents may face a decision about whether or not to carry the fetus to term.

Regardless of the moral and ethical problems associated with predicting genetic futures, the technology that makes it possible is impressive, and it provides only a glimpse of what will be possible in the future. The Human Genome Project was completed in 2001. Scientists now have a detailed “map” of the locations of each of the approximately 100,000 gen pairs in the human genome. The genetic information obtainable about an individual will range from personality and behavioral traits to a broad spectrum of hereditary disorders. Many experts fear that the temptation to misuse or misapply this information may be overwhelming.

**Genetic Screening in the Future**

The primary goal of the Human Genome Project is to provide improved treatment, prevention, and cures of genetic disorders. However, it is feared that genetic information may be used for purposes other than those intended.

In today’s competitive society, employers and insurance carriers seek to control costs at every opportunity. Many biologists and social scientists are expressing concern that these agencies will seek to use the information coming from the Human Genome Project to screen prospective employees and policyholders. Scientists think that tests can be developed to indicate high risk for genetic illnesses, susceptibility to heart disease, alcoholism, and perhaps even personality or behavioral disorders. Positive test results for any of these problems might be used to deny employment or insurance coverage.

Genetic tests, like most medical tests, are imprecise except for tests for single-gene diseases. At best, they provide a predictive and diagnostic tool. Just because a person has a predisposition to a disease like alcoholism, for example, does not mean he or she will develop the disease. The use of questionable test results to justify denial of employment or insurance coverage would be unfair.

New technologies being developed to student the human genome are powerful, and will provide information about an individual’s genetic makeup that has never before been available. What if anything, should be done with this information? Who should be allowed to see it? And who will decide the answers to these questions?

**Answer the following questions on a separate piece of paper.**

1. What was the Human Genome Project?
2. What type of abuse or misuse of genetic information to biologists and social scientists fear?
3. Who should have access to an individual’s genetic makeup?
4. What should genetic information be used for? Suggest measures that might be take to limit access to this information.

**2. Should Genetics Be Used to Improve Humans?**

In 1978, the first successful in vitro fertilization procedure was performed on a human. The purpose of this procedure was to enable women with certain reproductive disorders to bear children. While this goal was achieved, the procedure also gave rise to a number of ethical, legal, and moral issues.

As research provides more and more information about the human genome, it may become possible for scientists to manipulate human genetic material on an unprecedented scale. The potential development and use of such techniques will raise very difficult questions. Many of these questions will center on the use of technology to “improve” the human species.

**Clones and Genetic Engineering**

Not too many years ago, cloning was the stuff of science fiction. In cloning, an exact duplicate of an individual is developed from a few cells of that individual.

Today, techniques have been developed that produce genetic duplicates of a cell. Cloning is no longer science fiction. In 1996, scientists in Scotland created a clone using genetic material taken from the udder of an adult mammal. It is possible that the techniques used might one day enable scientists to clone humans.

Techniques such as cloning, and other genetic manipulations are generally called genetic engineering. Genetic engineering can be thought of as the “redesigning” of organisms by changing their genes. The most important technique used in genetic engineering is the combination of DNA from two different cells. This technique is called recombinant DNA technology. Genetic engineering has successfully developed methods of producing large quantities of certain vaccines, and drugs such as insulin and interferon.

Genetic engineering has raised concerns that the techniques used to “redesign” organisms might be applied to humans. Genetic engineering could make possible a modern – day eugenic movement to alter the genetic make-up of people deemed to be undesirable.

**Trait Selection**

At present, the fears that genetic engineering might lead to extreme alterations of humans seem unfounded. However, the mapping of the human genome does present the possibility of parents being able to “select” certain traits for yet-to-be-conceived offspring. It is already possible to detect the sex of in vitro embryos and to screen the embryos for certain genetic disorders, such as Down syndrome.

When the human genome map has been completed, it will be possible to screen embryos for a broad spectrum of genetic disorders and inherited traits. Thus, future generations of prospective parents may be able to select, to a limited degree, some of the physical traits they will pass on to their children. It may even be possible for parents to make decisions regarding certain mental and personality traits.

**Answer these questions on a separate piece of paper.**

1. What is recombinant DNA technology?
2. What is the benefit of Genetic engineering in the field of medicine?
3. Under what circumstances should doctors be allowed to change the genes of patients? Support your opinion with facts.
4. Should genetic engineering be used to improve the human species? Support your answer.

**3. Should Genetically Engineered Bacteria Be Released into the Environment?**

When people hear the word *bacteria*, they usually think of germs and illness – and with good reason. Many infectious diseases are caused by bacteria. But bacteria serve many beneficial functions as well. They are an important part of the ecosystem, recycling nutrients from dead tissue back into the food web. We use bacteria for many purposes, including making yogurt and cheese.

Genetic engineering has greatly expanded the ability of scientists to use bacteria . Genes from other organisms can be placed in bacteria to create new traits. For example, the gene for human insulin production has been successfully inserted into bacteria causing the bacteria to produce the hormone.

Other potential uses for genetically engineered bacteria involve the release of bacteria into the environment. Such microbes could be used to improve agricultural production or help in the environmental cleanup. However, many people strongly object to the deliberate release of new life forms into the environment.

**Supporting Points**

In April 1987, near Brentwood, California, scientists field-tested an altered form of *Pseudomonas syringae*, bacteria that normally grows on the surface of many crops, including strawberries. Normal *P. syringae* contain a gene that promotes the formation of ice crystals on crops. In the genetically altered bacteria, commonly called *ice-minus­,* the ice forming gene had been removed. Spraying the crops with ice-minus bacteria protected them from frost damage. Scientists believed that this protection would reduce the amount of frost damage, lengthen the growing season, and save billions of dollars in crop loss.

Genetically engineered bacteria have many potential environmental uses. Bacteria that consume wastes, such as plastic or old automobile tires, could reduce some of the problems of waste storage. Other bacteria could be engineered to act as pesticides or to remove toxic wastes from the soil.

As the human population continues to increase, the need for more productive agriculture and more effective waste disposal systems also increases. Genetically engineered bacteria may help to solve these environmental problems.

**Opposing Points**

Many, including scientists, objected to the release of the ice-minus bacteria in 1987 because they did not believe any engineered bacteria should be released into the environment.

It is impossible to accurately predict what will happen to microbes after they have served their function, or how they might affect other organisms. Although the developer of the bacteria inteds to keep them under controlled, contained conditions, there is always the possibility of accidental release. Consider what might happen if tire-eating bacteria escaped and reproduced freely. Because bacteria cannot tell the difference between good tires and waste, all rubber tires would eventually become useless!

The release of new organisms into an ecosystem affects the whole system. This process has been observed when new species of plants or animals are introduced into new habitats. Introduced organisms may aggressively compete with an displace native species. This would affect the populations of predator and prey organisms that normally coexist with the displaced species. Eventually, the whole ecosystem could be disrupted.

The balance of nature is very delicate. All living things play a role in their environment, whether people understand or appreciate the role or not. IT may be unwise to endanger the intricate web of life by releasing new microbes whose activities cannot be predicted with absolute certainty.

**Answer the following questions on a separate piece of paper.**

1. In what ways could genetically engineered bacteria be useful in the environment?
2. What risks are associated with the release of engineered bacteria?
3. If you were a strawberry farmer, would you use ice-minus bacteria on your crops if it meant a 10% increase in your productivity. Explain your reasoning.
4. Suppose there were bacteria that could destroy mosquito larvae, reducing the number of mosquitoes in your area all summer long. Would you encourage the release of such bacteria? Why or why not?

**4. Is the Cause of Alcoholism Genetic or Environmental?**

Alcoholism has been a social problem for centuries. Most societies have disapproved of public displays of drunkenness and disorderly behavior. Some societies have tried to discourage drunkenness by various punitive measures. Many people feel the stigma of having problem drinkers in their families and often try to keep the problem a secret.

**What is Alcoholism?**

Any person who drinks an alcoholic beverage is affected by it. Alcohol is a depressant, it decreases the ability of the nervous system to perform its functions. When someone drinks alcohol faster than their body can process it, the level of alcohol in their bloodstream increases. The more alcohol in the blood, the greater its effects will be. The outward signs of the effects of alcohol range from a slight reduction in reaction time to unconsciousness or death. Everyone who has too much to drink will show the effects of alcohol and will become drunk.

Obviously, not every person who drinks alcohol is an alcoholic. For centuries, however, there has been a common perception that some people may be prone to chronic alcoholism. Any person who needs the effects that alcohol produces in his or her body can be considered an alcoholic. Many alcoholics lead seemingly normal lives, yet are physically or psychologically dependent o alcohol to some degree. Alcoholics include all of the people who need a drink – to relax in the evening or to get started in the morning. Others need a drink to get to sleep or to face an unpleasant task. People who need alcohol are not in total control of their lives. Most alcoholics think that they could not live without alcohol.

**Alcoholism – “Nature or Nurture”?**

Since alcoholism was formally recognized as a disorder in the 1950’s, there have been two conflicting points of view about its root cause. The controversy has been between nurture and nature – environment or heredity. One viewpoint is that environment is the most important influence and causative factor in alcoholism. The other viewpoint is that the problem of alcoholism is largely hereditary.

Alcoholism is an environmental disorder in the sense that no one becomes an alcoholic unless he or she takes a drink. The likelihood of alcoholism is greatest in homes where people drink alcoholic beverages. Children see what their parents do and follow their example. In this context, drinking is like playing golf, or voting for a certain party. Whether or not someone becomes an alcoholic depends on personal choice. Thus, advocates of the environmental viewpoint argue, eye color is inherited, alcoholism is not.

People who advocate the hereditary cause of alcoholism point out that alcoholism tends to occur in families, sometimes extending over several generations. The fact that alcoholism sometimes lasts several generations suggests that there is a hereditary factor in the condition.

**The Stockholm Adoption Study**

The major problem in doing genetic studies of humans is the difficulty in obtaining samples that are large enough. Unlike *Drosophila*, people just do not produce lots of offspring. Also, humans cannot be studied under controlled conditions.

In the 1980’s, a unique situation was presented to C. Robert Cloninger, an American psychiatrist trained in population genetics. He was invited by Michael Bohman, head of the psychiatric department at the University of Sweden, to assist in a study of alcoholism in Sweden. This study today is called the Stockholm Adoption Study.

The subjects of the study were all adopted children of unmarried mothers. One or both of the natural parents were alcoholics, but the children had always lived apart from their natural parents. Complete records of members of all families were available for several generations. A brief summary of the results shows the following.

* There are two degrees, or types of alcoholism: severe, or Type II alcoholism, and less severe, Type I alcoholism
* Many children of Type II alcoholics themselves became Type II alcoholics, regardless of their environment. This suggests a possible strong genetic component to Type II alcoholism.
* Children of Type I alcoholics tend to become Type I alcoholics. However, many of these children, if influenced by environmental factors, become Type II alcoholics.
* Males are much more likely to become alcoholics than are females.

In 1987, Cloninger proposed a theory based on his findings. He suggested that three personality types make up the two types of alcoholics. Furthermore, he suggested, the traits shown by each personality type have a hereditary basis. Each of these traits is controlled by a different chemical in the nervous system. For simplicity, call the chemicals A, B, and C. Chemical A produces active or adventurous behavior. Chemical B inhibits such behavior and acts as a brake or control. Chemical C produces behavior that is characterized as reward-seeking, such as looking for social approval.

The activation of these chemicals is regulated by different genes, called alcohol susceptibility genes. Alcohol-susceptibility genes determine how the central nervous system reacts to the outside world. For example, in one person a particular stimulus might result in the activation of chemical A. For another person, the same stimulus might activate chemical B or C.

According to Cloninger’s theory, a person who inherits a nervous system that produces large amounts of chemicals B and C and only small amounts of chemical A is susceptible to becoming a Type I, environmentally influenced alcoholic. Conversely, a person who inherits a nervous system that produces large amounts of chemical A and small amounts of B and C is susceptible to becoming a Type II alcoholic.

As indicated earlier, alcoholism is much more prevalent in males than in females. Cloninger’s study indicated that in females, the susceptibility genes controlled a different disorder – eating. Evidence indicates that such compulsive eating disorders as overeating to obesity and under eating to anorexia are controlled by the same genes.

To date, research by Cloninger and other independent researchers seems to support the findings of this study. In the meantime, researchers continue to study the possible genetic origins of alcoholism, relying on molecular biology, gene mapping, and linkage analysis for their investigations.

**Answer the following questions on a separate piece of paper.**

1. How does alcohol affect the human body?
2. How does an alcoholic differ from an occasional drinker?
3. How do the actions of alcoholic-susceptible genes in males manifest themselves in females?

**5. Genetic Testing for Breast Cancer**

The recent discovery of a gene that is believed to cause breast cancer has led to the development of tests to detect this gene. Such discoveries in breast cancer are the subject of much debate. Few people question the benefit of having tests to detect an increased risk of breast cancer, but many wonder how the results of this testing would be used by patients, doctors and insurance companies.

Letitia Jones is the mother of two daughters and a son. Her mother and a sister both died of breast cancer. Letitia is aware that many cases of breast cancer are hereditary. Her doctor has told her about a genetic test, called a marker, which can tell whether a person has the defective gene that causes breast cancer. The test costs between $750 - $1000. Letitia knows that early detection of breast cancer offers the best chance for survival. She decides to have the test and asks her insurance company to pay for it. They agree.

The genetic test results are positive, meaning Letitia has a genetic risk of developing breast cancer. Letitia is now faced with some difficult decisions. Her doctor discusses two possible courses of action with her. Either she can continue to have regular breast exams to detect any cancer she may develop, or she can have both breasts removed as a preventative measure.

Letitia could have the surgery for some peace of mind, but her insurance company refuses to pay for the procedure because she does not currently have breast cancer. Also, they claim, the surgery might be unwarranted because she may never develop the disease. Even if she has the operation, removing her breasts does not completely eliminate the risk of cancer – the gene responsible is still in Letitia’s body.

Letitia’s sister Susan does not want to have the test. Susan has two children, a daughter and a son. Susan’s daughter Carol, who is fifteen wants to have the test, but knows that the results may be upsetting for her mother. If the test is positive, not only does the daughter have potential to develop breast cancer, but she must have inherited the gene from Susan.

**Answer the following questions on a separate piece of paper.**

1. Do you think Letitia made the right decision to have the test? Why or why not?
2. If Letitia decides she wants to have her breasts removed, should the insurance company pay for the operation? Why or why not?
3. Should Susan’s daughter be able to decide for herself whether she wants to have the test? If she decides to have the test, who should pay for it? Why?
4. Do you think the operation can be considered a form of preventative medicine? Why or why not?

**6. Is Organically Grown Food Really Better for You?**

If not properly maintained, farmland can wear out. The nutrients and organic matter in fertile topsoil are not permanent parts of the soil. Plants remove nutrients from the soil and use them to grow. Organic matter breaks down. If nutrients are not replaced, the soil loses its fertility.

**Conventional Farming**

At one time, farmers replenished nutrients and organic matter by adding solid animal wastes and unused plant parts to topsoil. Today they rely mainly on synthetic fertilizers. Most synthetic fertilizers contain phosphorus, potassium, and nitrogen. The application of fertilizers to the soil can restore fertility. It does not, however, replenish organic matter or some trace elements essential for plant growth and human nutrition.

Crop yields may be kept high through the exclusive use of synthetic fertilizers, but the equality of the topsoil will slowly degrade. This degradation is called *mineralization*. Mineralized soil loses its ability to hold water. Extensive irrigation is required to maintain yields of crops grown in mineralized soils.

Potential damage to the surrounding ecosystem is another drawback of synthetic fertilizer use. Minerals in the fertilizer may be dissolved in rainwater and washed from the soil into local water systems, causing contamination of water supplies.

Pesticides, which are chemicals used to control pests, can also cause problems. Some farmers use large amounts of these chemicals to kill insects and weeds and to control organisms that cause plant diseases. Many pesticides are harmful to people and to a wide variety of wildlife. In some cases, harm is caused by direct exposure to the chemicals. In other cases, the chemicals enter the food chain and become harmful to organisms that consume them. Pesticides, like fertilizers, can contaminate water supplies.

Some agricultural use of pesticides is unavoidable. In the past, entire crops have been wiped out by insects and disease. But some people argue that pesticides are used too frequently. They claim many pesticides have not been well tested for possible harmful effects.

**Organic Farming**

Some farmers are now returning to relying on nature. These farmers operate organic farms. Organic farming avoids the use of pesticides, food additives, or synthetic fertilizers whenever possible. Foods grown on these farms are called organic foods. Organic farmers rely on solid animal wastes, crop rotation, composting, minimum tillage, and biological best control instead of fertilizers and pesticides.

Yields of some organically grown crops are smaller than those of conventionally grown crops. However, the profits are about the same, because of lower costs. Organic farmers use considerably less energy, and do not have to pay for pesticide and fertilizer application.

In addition to producing somewhat smaller yields, organic farming does have other drawbacks. Organic fertilizers may not replace all of the nutrients removed by crop plants. Also, the transition from conventional farming takes three to five years. During that period, crop yields and profits may be low. There are some consumers today who will buy only organically grown produce, and their numbers are growing. They feel that organic food is healthier. They also claim that it tastes better. These claims are disputed by farmers who use conventional methods for raising crops. There is no disputing the fact however, that if chemicals are not used, they will not be on the resulting crop.

**Answer the following questions on a separate piece of paper.**

1. What are some of the disadvantages to the exclusive use of synthetic fertilizers to replenish soil nutrients?
2. What are the drawbacks to organic farming.
3. What is organic farming? How does organic farming differ from conventional farming?
4. Do the benefits of organic farming outweigh the drawbacks? Support your answer.