Bioethics

4. Genetic Engineering

* 1. Intended Learning Outcomes

By the end of the lessons, the students will be able to:

1. Understand the meaning of genetic engineering and its usages in various aspects like agriculture and food industry, medicine, research, and entertainment etc.
2. Evaluate the impacts of genetic engineering on our daily life.
3. Analyze the moral issues raised in the development of genetic engineering.
4. Apply different ethical theories to make moral judgment on genetic engineering.

*\*Prerequisite knowledge: Normative Ethics, the nature of morality, moral principles, moral reasoning, theory of conduct, theory of value & virtue (Refer to* [*‘NSS Ethics and Religious Studies Curriculum Support Materials - Compulsory Part: Ethics - Module 1: Normative Ethics’*](http://www.edb.gov.hk/en/curriculum-development/kla/pshe/references-and-resources/ethics-and-religious-studies/support-materials-compulsory-part-module-1-normative-ethics.html)*)*

* 1. Introduction

Genetic engineering is the artificial manipulation, modification, and recombination of DNA (i.e. the carrier of genetic information which achieves its effects by directing the synthesis of proteins) or other nucleic acid molecules in order to modify an organism or population of organisms. An organism generated through genetic engineering is considered to be a genetically modified organism (GMO). The technology was invented in the 1970s and has flourished rapidly in the past 3 decades in various fields, including agriculture and food industry, medicine, research, and entertainment etc.

The development of genetic engineering and its applications on plants, animals and human beings have aroused huge ethical controversies over the world. According to the information provided by the World Health Organization (WHO), ‘*Switzerland is the only country that has made a vote on genetic engineering in the future, with nearly two-thirds of its population voting against a referendum to ban genetic engineering.*’

In these lessons, students will evaluate the impacts of genetic engineering on our daily life, and analyze the moral issues raised in its development, especially those related to genetically modified (GM) foods and human genetic engineering.

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| **References:**   * Beauchamp, T.L. (et al.) (2008). *Contemporary Issues in Bioethics.* USA: Thomas Higher Education. * Shannon, T.A. (1997). *An Introduction to Bioethics*. New York: Paulist Press. * <http://en.wikipedia.org/wiki/Genetic_engineering> * <http://www.globalchange.com/geneticengin.htm> * <http://www.who.int/genomics/public/patientrights/en/> |

* 1. Teaching and learning processes

Suggested teaching period: 4 lessons

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| * 1. Definition of Genetic Engineering (GE)   2. Prior to the lesson, teacher asks students (individually or in groups) to search for and take photos if possible or download photos from internet of some genetically modified foods (GM foods) and non-GM foods in a supermarket.   3. During the lesson, students present their findings.   4. Teacher asks, ‘Would it affect your decision on whether or not to buy genetically modified food? Why or why not?’   5. Teacher shows some items of genetically modified food one by one (cf. Photo 1-6) and asks if students would eat/drink them. Students are also required to provide explanations.   6. Teacher asks students to complete ‘Worksheet 1: Genetic Engineering – why and what?’ Then, teacher asks the students to vote and facilitates a class discussion.   7. GM foods controversy   2.1. Teacher plays (twice if necessary, or instruct students to watch it before coming to lessons / tell students to search for similar video in Chinese) the following 3 videos and asks the students to complete ‘Worksheet 2: Genetically Modified (GM) foods and you’. Check their answers afterwards.   * ‘How Are GMOs Created?’ (~5 mins) at *https://www.youtube.com/watch?v=2G-yUuiqIZ0* * ‘10 Worrying Facts About Genetically Modified Food’ (~3 mins) at [*https://www.youtube.com/watch?v=OB\_0OLKGMpQ*](https://www.youtube.com/watch?v=OB_0OLKGMpQ) * ‘Genetically Modified Organism (GMO) - Myths and Truths’ (~6 mins) at [*https://www.youtube.com/watch?v=M\_ztZGbLEJ0*](https://www.youtube.com/watch?v=M_ztZGbLEJ0)   2.2. Forum on GM foods – Teacher separates the students into 6 groups, with each group performing one of the following roles: (a) consumers; (b) GM foods manufacturers; (c) environmentalists; (d) farmers; (e) scientists; (f) religious leaders. Students may prepare their presentation by referring to the information on Worksheet 2 in the class, or by searching for additional information after class. Then, teacher (or a designated student) facilitates the forum. During the forum, students may jot down notes and do a peer evaluation using ‘Worksheet 3: Forum on GM foods’.  3. Human Genetic Engineering  3.1. Teacher plays (twice if necessary) the video on ‘Human Genetic Engineering’ (~8 mins) at [*https://www.youtube.com/watch?v=dKBfxoPnT7g*](https://www.youtube.com/watch?v=dKBfxoPnT7g), and asks the students to complete ‘Worksheet 4: Human Genetic Engineering’ in pairs.  3.2. Teacher facilitates a class discussion.   1. Conclusion and students’ self-evaluation    1. Teacher reviews the key learning points of the topic on ‘genetic engineering’ with the students.    2. Ask students to consolidate their knowledge and evaluate their learning outcomes by completing ‘Worksheet 5: Summary & self-evaluation’. |

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| **Photo 1: Genetically Modified soybean**  http://www.nutricion.pro/general/consejos-nutricionales-para-alergia-a-la-caseina/  Soy has been genetically modified to resist herbicides. In 2007, over half of the world's soybean crop (58.6%) was genetically modified.  References:  <http://consciouslifenews.com/gmo-alert-top-10-genetically-modified-foods-avoid-eating/>  http://www.gmo-compass.org/eng/grocery\_shopping/crops/19.genetically\_modified\_soybean.html |
| **Photo 2: ‘Fishy’ tomatoes & strawberries**  [https://encrypted-tbn2.gstatic.com/images?q=tbn:ANd9GcS00IVrzmmFJxP7DYq9X1BY_AOgle5J3Kf2CxO2E5FEF68Z3KW_pYA5LN1Y](http://www.google.com.hk/url?url=http://feelgrafix.com/956605-tomato.html&rct=j&frm=1&q=&esrc=s&sa=U&ei=yc8kVfuVBM3v8gX9koCQDw&ved=0CBcQ9QEwAQ&sig2=TJ2IrqG7x4yBE3e6WJryIg&usg=AFQjCNHetJDWQ9TSEaS0nfx-FWMpSqZQZA)http://www.foodincanada.com/wp-content/uploads/2013/12/fish1.jpg[Strawberry](http://dreamatico.com/data_images/strawberry/strawberry-4.jpg)  Genetic engineers inject arctic fish genes into tomatoes and strawberries to make them frost-tolerant. For vegetarians, plants containing animal genes may hardly be acceptable.  Reference: <http://thegreendivas.com/2011/06/10/waiter-theres-a-fish-in-my-tomato-a-gmo-story/> |
| **Photo 3: Sorpio cabbage**  [Scorpion Venom Research Facts](http://www.scorpionworlds.com/wp-content/uploads/venom-Scorpion_624.jpg)[http://2.bp.blogspot.com/-LtmW_ktxtXU/Um28ElCtQnI/AAAAAAAAB04/aaXWbmTdbnE/s320/cabbage.png](http://2.bp.blogspot.com/-LtmW_ktxtXU/Um28ElCtQnI/AAAAAAAAB04/aaXWbmTdbnE/s1600/cabbage.png)  Genetic engineers combine the gene of poison in the tail of a scorpion with a cabbage. These genetically modified cabbages kill caterpillars.  Reference: <http://www.globalchange.com/geneticengin.htm> |
| **Photo 4: Genetically Modified salmon**    https://www.google.com.hk/search?q=GM+salmon&espv=2&biw=999&bih=514&tbm=isch&imgil=FatNbN5fhVQCzM%253A%253BXGAA7yGout\_G-M%253Bhttp%25253A%25252F%25252Fwww.bluechannel24.com%25252F%25253Fp%2525253D23564&source=iu&pf=m&fir=FatNbN5fhVQCzM%253A%252CXGAA7yGout\_G-M%252C\_&usg=\_\_79umyAac\_4S5xqGuLmINv8jgmzE%3D&dpr=1&ved=0CDIQyjc&ei=mLMkVcDNNMLt8gWt8IGQDA#imgrc=sQDDj5g7QSWqkM%253A%3BNXZaRXMOCu8X0M%3Bhttp%253A%252F%252Fscienceprogress.org%252Fwp-content%252Fuploads%252F2011%252F09%252Fgmo\_salmon\_compare.jpg%3Bhttp%253A%252F%252Fscienceprogress.org%252F2011%252F09%252Fthe-gmo-salmon-struggle%252F%3B468%3B269  The biotechnology industry says it has genetically modified a fish that grows at twice the normal rate, so it can get to market sooner and make more money faster.  Reference: http://www.foodandwaterwatch.org/food/genetically-engineered-foods/stop-frankenfish/ |
| **Photo 5: Silky spider goat milk**  [wolf spider](http://www.domyownpestcontrol.com/images/content/wolf%20spider.jpg)goat  Genetic engineers have created goats with spider [genes](http://www.globalchange.com/index.php?option=com_content&view=article&id=219) that create "silk" in their milk. Apart from increasing the silkiness of the beverage, scientists also use its spider web protein to make bulletproof vests.  However, religious groups such as Orthodox rabbis (Jewism) or Muslim leaders perceive such milk as ‘non-kosher’ or ‘non-halal’ – i.e. unclean/forbidden.  References:  <http://www.globalchange.com/geneticengin.htm>  <http://thegreendivas.com/2011/06/10/waiter-theres-a-fish-in-my-tomato-a-gmo-story/>  http://219greenconnect.com/wp-content/uploads/2013/10/GMO-food-Controversy.pdf |
| **Photo 6: Chickens with multiple legs and wings**  <http://www.businessinsider.com/kfc-mutant-chickens-are-not-real-2014-2>  (This is NOT a real photo. In 2014, a rumor that KFC uses mutated chickens with extra limbs is going viral on Facebook and Twitter.  Read more: <http://www.businessinsider.com/kfc-mutant-chickens-are-not-real-2014-2#ixzz3Y1TM3t2T>)  Theoretically, genetic engineers are able to create chickens with multiple legs and wings to cope with the increasing demand on chicken consumption.  Reference: http://www.globalchange.com/geneticengin.htm |

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| **Worksheet 1: Genetic Engineering – why and what?**  *Read the following information and then answer the question below.*   |  |  |  |  | | --- | --- | --- | --- | | **Definition of ‘genetic engineering’**  Genetic engineering is the artificial manipulation, modification, and recombination of DNA (i.e. the carrier of genetic information which achieves its effects by directing the synthesis of proteins) or other nucleic acid molecules in order to modify an organism or population of organisms. An organism generated through genetic engineering is considered to be a genetically modified organism (GMO). The technology was invented in the 1970s and nurished rapidly in the past 3 decades in various fields, including agriculture and food industry, medicine, research, and entertainment etc.  **Agriculture and food industry** – GM foods has been selling in the markets since 1900s. New genes are introduced for a variety of reasons, whether it's to grow higher yields, make crops more resistant to infection and pests, or even to infuse them with extra nutrients and vitamins. Some common GM foods include: milk, soy, corn, potatoes, rice, papaya, tomatoes, canola, etc.  **Medicine** - Genetic engineering has been widely used in the medical field. Insulin and human growth hormone were the first 2 commercial medical products. Other medicine or treatment for cancer, immune deficiency, heart attacks etc. have also been produced using genetic engineering. In addition, vaccines and artificial transplanting organs created with DNA technolgy are also available. Futhermore, gene therapy has become more and more prevailing in both preventive and remedial ways while malfunction genes are detected.  **Research** - Genetic engineering unvails a new chapter in natural science. Genes and other genetic information from a wide range of organisms are transformed into bacteria for storage and modification, creating genetically modified bacteria in the process. Bacteria are cheap, easy to grow, clonal, multiply quickly, relatively easy to transform and can be stored at -80 °C. An isolated gene can be stored inside the bacteria providing an unlimited supply for research and experiments.  **Entertainment** – Novelties such as glowing pets, lavender-colored carnations, blue roses, BioArt etc. are made available for trend-followers.   |  |  |  | | --- | --- | --- | | GloFish  http://www.thatpetplace.com/aquarium-livestock/glofish#!glofish | Glowing kitten  <http://www.livescience.com/15994-glow-dark-cats-aids-virus-research.html> | BioArt  http://en.wikipedia.org/wiki/BioArt |   **References:**  <http://en.wikipedia.org/wiki/Genetic_engineering>  http://en.wikipedia.org/wiki/GloFish  http://gmoinside.org/gmo-timeline-a-history-genetically-modified-foods/  http://global.britannica.com/EBchecked/topic/228897/genetic-engineering  http://recipes.howstuffworks.com/5-common-genetically-modified-foods.htm http://www.infoplease.com/cig/biology/dna-technology-applications.html |   In which of the following aspects do you think it is worthwhile to develop genetic engineering? Why or why not?   |  |  |  | | --- | --- | --- | | **Aspect** | **Worthiness of development**  5= very worthy, 1= not worthy at all | **Reasons** | | Agriculture and food industry | 5 4 3 2 1 |  | | Medicine | 5 4 3 2 1 |  | | Research | 5 4 3 2 1 |  | | Entertainment | 5 4 3 2 1 |  | |

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| **Worksheet 2: Genetically Modified (GM) foods and you**  **Task A:**  Watch the video on **‘How Are Genetically Modified Organisms (GMOs) Created?’** at [*https://www.youtube.com/watch?v=2G-yUuiqIZ0*](https://www.youtube.com/watch?v=2G-yUuiqIZ0), and answer the question.  1. What are the **advantages** of GM foods (e.g. GM papaya)?   |  | | --- | |  |   **Task B:**  Watch the video on ‘**10 Worrying Facts About Genetically Modified Food’** at [*https://www.youtube.com/watch?v=OB\_0OLKGMpQ*](https://www.youtube.com/watch?v=OB_0OLKGMpQ), and answer the question.  2. What are the **disadvantages** of GM foods?   |  | | --- | |  |   **Task C:**  Watch the video on **‘Genetically Modified Organism (GMO) - Myths and Truths’** at [*https://www.youtube.com/watch?v=M\_ztZGbLEJ0*](https://www.youtube.com/watch?v=M_ztZGbLEJ0), and answer the question.  3. What are the counter arguments for the viewpoints concerning GM foods below?   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | *\*Fill in the blanks using the words below. Some can be used more than once.*   |  |  |  | | --- | --- | --- | | seeds | biodegradable | uncontrolled | | nutritional content | plant diseases | crop performance | | allergenic | chemically farmed | nutrients | | fossil fuel | food supply | environment | | greenhouse gases | mutations | safety studies | | allocation of resources | herbicides |  | |  |  |  | | --- | --- | | **Pro-GM foods arguments** | **Counter Arguments** | | Increase crop yields | GM crops do not increase intrinsic yield. Some GM herbicides kill natural (1) and organisms in the soil, leading to (2) . | | Lower cost for farmers | Farmers have to pay more for GM (3) and (4) . | | Reduce use of herbicides / pesticide | GE in fact leads to increasing use of herbicides / pesticide. Some GM herbicides (e.g. ‘Roundup’ herbicide) are not (5) as claimed, and even are ‘dangerous for the environment’ | | Genetic Engineering (GE) is a safe and beneficial process, and it is an extension of natural plant propagation | It is a lab-based technique where a foreign gene is inserted into the DNA of the plant.  This is an (6) process, because the site of insertion is random and may potentially damage the plant’s genetic makeup.  The (7) that occur during the genetic engineering process can lead to many unexpected changes, such as:   * poor (8) * alteration in the food’s (9) * toxic & (10) effects * unforeseen harm to the (11) . | | GE is a climate change solution | GE does nothing to solve the growing global problem. GM crops are as energy-hungry as any other  (12) crops because they are largely dependent on herbicides made with (13) . Furthermore, they depend on nitrogen fertilizer which emits (14) . | | GMOs are energy-friendly because of the ‘no-till method’, which reduces the number of tractor passes | Research reveals that even though the no-till method did reduce farm operations, large amounts of energy are still consumed due to the production of  (15) used on GM crops. | | GE helps eliminate world hunger | GE will not help eliminate world hunger. It does not protect the security of our (16) . There are no GE crops available that increase intrinsic yield.  World hunger is actually an issue of (17) . | | GMOs are safe | There are no conclusive (18) on GMOs, as independent researchers are prohibited to use GE crops for their studies. | |

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| **Worksheet 2: Genetically Modified (GM) foods and you**  ***(For teachers’ reference)***  **Task A:**  Watch the video on **‘How Are Genetically Modified Organisms (GMOs) Created?’** at [*https://www.youtube.com/watch?v=2G-yUuiqIZ0*](https://www.youtube.com/watch?v=2G-yUuiqIZ0), and answer the question.  1. What are the **advantages** of GM foods (e.g. GM papaya)?   |  | | --- | | * Resistant to bacteria/virus (diseases), pests, weeds and droughts; * Reduce the use of pesticide which is harmful to the environment; * Provide improved nutrition; * Increase crop and provide steady food supply to consumers; * Cheaper cost for consumers; * Enhance the food quality |   **Task B:**  Watch the video on ‘**10 Worrying Facts About Genetically Modified Food’** at [*https://www.youtube.com/watch?v=OB\_0OLKGMpQ*](https://www.youtube.com/watch?v=OB_0OLKGMpQ), and answer the question.  Genetic engineering: The world's greatest scam?  <https://www.youtube.com/watch?v=1H9WZGKQeYg> (英文版)  <https://www.youtube.com/watch?v=doxTzjCQ5Ds> (中文字幕)  2. What are the **disadvantages** of GM foods?   |  | | --- | | * A pesticide made from scorpion poison has been injected into cabbages, which may be harmful to the consumers. * Studies suggest that animals on GM diets are at greater risk of developing cancer, and are more likely to have infertile offspring. * Consumers may not have informed choice of food. 70% of the food items on shelves in US contain GMOs, but many of them are unlabeled. * GM foods may have a link to some human diseases – e.g. Morgellons disease (an illness creates a sensation of bugs crawling underneath the skin), allergies, bleeding stomachs, or even deformities. * GMOs may cause unforeseen long-term side effects on the environment, since seeds cross-pollinate in the wild is uncontrollable. |   **Task C:**  Watch the video on **‘Genetically Modified Organism (GMO) - Myths and Truths’** at [*https://www.youtube.com/watch?v=M\_ztZGbLEJ0*](https://www.youtube.com/watch?v=M_ztZGbLEJ0), and answer the question.  3. What are the counter arguments for the viewpoints concerning GM foods below?   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | *\*Fill in the blanks using the words below. Some can be used more than once.*   |  |  |  | | --- | --- | --- | | seeds | biodegradable | uncontrolled | | nutritional content | plant diseases | crop performance | | allergenic | chemically farmed | nutrients | | fossil fuel | food supply | environment | | greenhouse gases | mutations | safety studies | | allocation of resources | herbicides |  | |  |  |  | | --- | --- | | **Pro-GM foods arguments** | **Counter Arguments** | | Increase crop yields | GM crops do not increase intrinsic yield. Some GM herbicides kill natural (1) nutrients and organisms in the soil, leading to (2) plant diseases. | | Lower cost for farmers | Farmers have to pay more for GM (3) seeds and  (4) herbicides. | | Reduce use of herbicides / pesticide | GE in fact leads to increasing use of herbicides / pesticide. Some GM herbicides (e.g. ‘Roundup’ herbicide) are not (5) biodegradable as claimed, and even are ‘dangerous for the environment’ | | Genetic Engineering (GE) is a safe and beneficial process, and it is an extension of natural plant propagation | It is a lab-based technique where a foreign gene is inserted into the DNA of the plant.  This is an (6) uncontrolled process, because the site of insertion is random and may potentially damage the plant’s genetic makeup.  The (7) mutations that occur during the genetic engineering process can lead to many unexpected changes, such as:   * poor (8) crop performance * alteration in the food’s (9) nutritional content * toxic & (10) allergenic effects * unforeseen harm to the (11) environment. | | GE is a climate change solution | GE does nothing to solve the growing global problem. GM crops are as energy-hungry as any other  (12) chemically farmed crops because they are largely dependent on herbicides made with (13) fossil fuel. Furthermore, they depend on nitrogen fertilizer which emits (14) greenhouse gases. | | GMOs are energy-friendly because of the ‘no-till method’, which reduces the number of tractor passes | Research reveals that even though the no-till method did reduce farm operations, large amounts of energy are still consumed due to the production of  (15) herbicides used on GM crops. | | GE helps eliminate world hunger | GE will not help eliminate world hunger. It does not protect the security of our (16) food supply. There are no GE crops available that increase intrinsic yield.  World hunger is actually an issue of (17) allocation of resources. | | GMOs are safe | There are no conclusive (18) safety studies on GMOs, as independent researchers are prohibited to use GE crops for their studies. | |

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| **Worksheet 3: Forum on GM foods**  Listen attentively to the viewpoints/concerns of the spokesmen in the forum. Jot down their views, and analyze their stands in the table below.   |  |  |  |  | | --- | --- | --- | --- | | **Role** | **Stands towards GM foods** | **Viewpoints / concerns** | **Challenging level (optional)**  **Critiques from deontological / utilitarian view points** | | **Consumers** | for / against |  |  | | **GM foods manufacturers** | for / against |  |  | | **Environmentalists** | for / against |  |  | | **Farmers** | for / against |  |  | | **Scientists** | for / against |  |  | | **Religious leader** | for / against |  |  |   Peer evaluation   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | Peer-evaluation (3=good, 2=average, 1=poor) | | | | | | | **Consumer** | **Manufacturer** | **Environmentalist** | **Farmer** | **Scientist** | **Religious leader** | | Clear standpoint | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | | Convincing viewpoints | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | | Substantial examples | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | | Logical presentation | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | | Accurate use of ethical theory | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | 3 2 1 | |

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| Worksheet 4: Human Genetic Engineering  Watch the video on ‘**Human Genetic Engineering’** at [*https://www.youtube.com/watch?v=dKBfxoPnT7g*](https://www.youtube.com/watch?v=dKBfxoPnT7g)*,*and answer the questions below:  Or: 人類基因解碼 <https://www.youtube.com/watch?v=7_FnMS1ocOs> (中文字幕) Discovery《人類基因解碼》剪輯版 <https://www.youtube.com/watch?v=UaWiAvNqoYU> (中文字幕)   * + 1. Imagine a world where you could pick your child’s traits ( like hair & eye color / height/ build/ intellegence/ chance of disease/ memory/ number of clones). Would this be a world you want to live in? Why or why not?  1. From the video and your own knowledge, what are the pros and cons of GE in the following aspects?  |  |  |  |  | | --- | --- | --- | --- | | **Aspects** | **Pros** | **Cons** | **Challenging level (optional)**  **Ethical concerns** | | * Designer babies * Gene selection * Gender selection * Trait selection |  |  |  | | Gene therapy |  |  |  | | Social-economic differences |  |  |  | | Military use |  |  |  | | Prolonged human life |  |  |  | | Others (please specify): |  |  |  |  1. Do you support applying GE on human? Please explain and defend your answer using the theories of ethics. |

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| Worksheet 4: Human Genetic Engineering  ***(For teachers’ reference)***  Watch the video on ‘**Human Genetic Engineering’** at [*https://www.youtube.com/watch?v=dKBfxoPnT7g*](https://www.youtube.com/watch?v=dKBfxoPnT7g)*,*and answer the questions below:   * + 1. Imagine a world where you could pick your child’s traits ( like hair & eye color / height/ build/ intellegency/ chance of disease/ memory/ number of clones). Would this be a world you want to live in? Why or why not?  1. From to the video and your own knowledge, what are the pros and cons of GE in the following aspects?  |  |  |  |  | | --- | --- | --- | --- | | **Aspects** | **Pros** | **Cons** | **Challenging level (optional)**  **Ethical concerns** | | * Designer babies * Gene selection * Gender selection * Trait selection | * Parents have the right to ‘design’ their offspring. * The human race as a whole would become more and more perfect. | * Human race would become more and more uniformed. * The attempt to design babies is to play God. * If genetically altered humans are successful, ones’ accomplishments would no longer be admired, because those achievements are not their own, but rather the products of science. | * Who is to say what are the best traits? * Is it ethical for parents to select their babies’ traits? | | Gene therapy | * Sometic engineering can be used to correct genes with defect that cause lifelong & deadly deseases (e.g. severe combined immunodeficiency). * It can cure disorders caused by genetic mutation (e.g. Down syndrome / Alzheimer’s disease). | * It could cause super diseases. * It may lead to unpredictable consequences and side effects. E.g. we can alter the genes of mice to increase its memory but it may become more sensitive to pain at the same time. That might also happen on human beings. | Engineered baby may be born to save the life of a brother/sister. Is it moral to design humans for such a purpose? | | Social-economic differences | Rich people can make their children more intellegent / aethletic. | Social-economic differences that would seperate genomic classes, causing discrimination. | Is it fair and just if the genomic classes are created in our future society? | | Military use | The gene of soilers’ eyes can be altered, such that they can see the infrared of the enemy in the dark for defense purposes. | The development of GE on military aspect could cause huge casualty. | Is it ethical to modify human genes to serve military purposes? | | Prolonged human life | Humans can enjoy longer life with better physical condition by modifying their genes. | * Overpopulation & lack of resources * It may lead to the development of new species of human. | Who have the right to determine how long a person should live? | | Others (please specify):  e.g. Human cloning *(will be discussed in next chapter)* |  |  |  |  1. Do you support applying GE on human? Please explain your answer using the theories of ethics. |

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| Worksheet 5: Summary & Self-evaluation – Genetic Engineering  Write down the key learning points of this module.   |  | | --- | | 1. **Definition of Genetic Engineering (GE)** | | 1. | | 2. | | 3. | | 4. | | 5. |  |  | | --- | | 1. GM foods controversy | | 1. | | 2. | | 3. | | 4. | | 5. |  |  | | --- | | 1. **Human Genetic Engineering** | | 1. | | 2. | | 3. | | 4. | | 5. |   **Evaluate how well you have learnt** (please put a ‘🗸’)   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Very good | Good | Fair | Poor | | 1. Definition of Genetic Engineering (GE) |  |  |  |  | | 1. GM foods controversy |  |  |  |  | | 1. Human Genetic Engineering |  |  |  |  |   What question(s)/area(s) you want to learn more in this module of ‘genetic engineering’? |