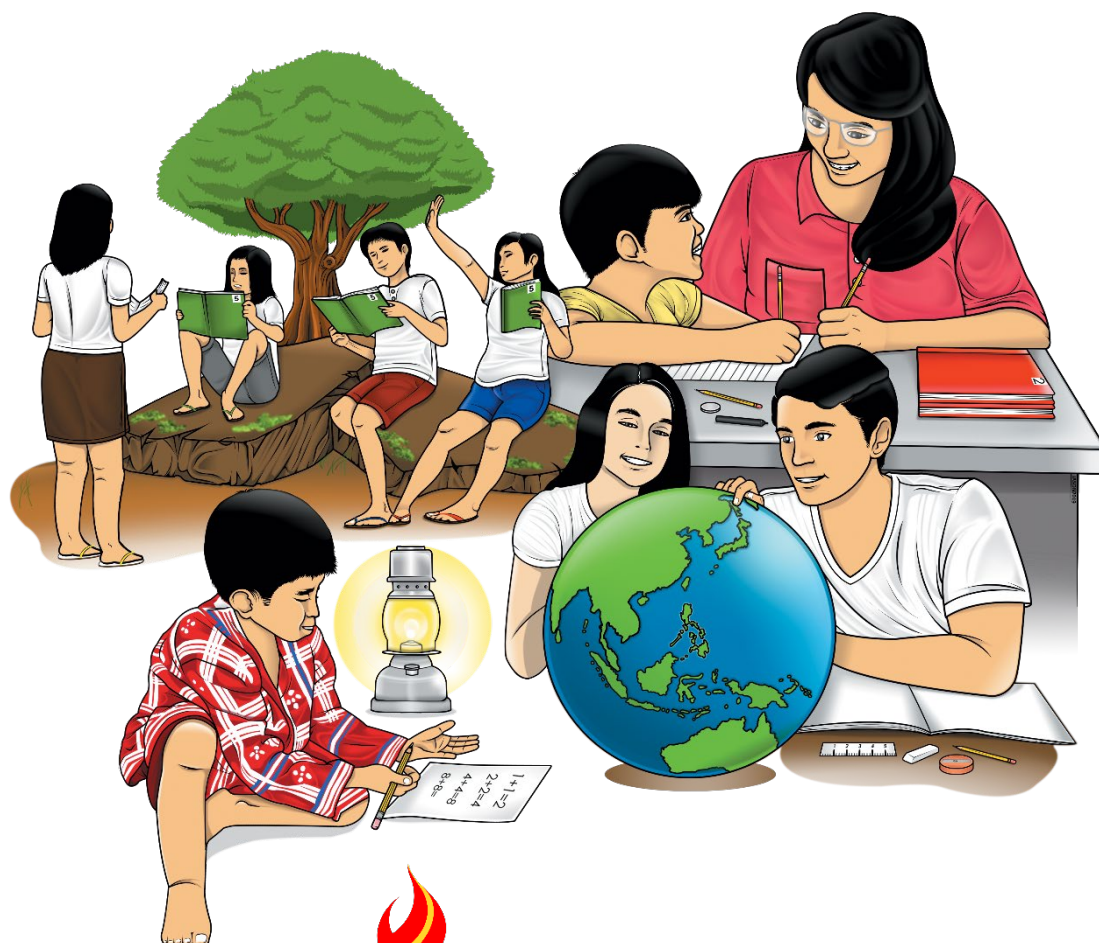


Senior High School

Earth and Life Science

Quarter 2 – Module 5:

Benefits of Genetically Modified Organisms



Earth and Life Science
Alternative Delivery Mode
Quarter 2 – Module 5: Benefits of Genetically Modified Organisms
First Edition, 2021

Republic Act 8293, section 176 states that: No copyright shall subsist in any work of the Government of the Philippines. However, prior approval of the government agency or office wherein the work is created shall be necessary for exploitation of such work for profit. Such agency or office may, among other things, impose as a condition the payment of royalties.

Borrowed materials (i.e., songs, stories, poems, pictures, photos, brand names, trademarks, etc.) included in this module are owned by their respective copyright holders. Every effort has been exerted to locate and seek permission to use these materials from their respective copyright owners. The publisher and authors do not represent nor claim ownership over them.

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Writers: Nerissa E. Manila

Editors: Melanie I. Samudio, Jocelyn M. Manset

Reviewers: Jason Ricaforte, Elizabeth A. Soriano, Princess Paolah L. De Guzman, Marissa C. Betchaida, Louie L. Alvarez, Gregorio M. De Chavez, Jr, Jocelyn M. Manset, Mario B. Maramot, Elaine T. Balaogan, Job S. Zape Jr., Catherine L. Lucero, Edmund M. Evangelista

Illustrator: Ednelinda Robles, Lovely Joy La Rosa, Charles Erick A. Jusay, Sandro Carlo B. Tablizo

Layout Artist: Elizalde L. Piol, Anselma M. Ebero, Jocelyn M. Manset, Argie L. Ty

Management Team: Francis Cesar B. Bringas
Job S. Zape Jr.
Eugenio S. Adrao
Elaine T. Balaogan
Merthel M. Evardome
Nadine C. Celindro
Nicolas M. Burgos
Mario B. Maramot
Fe M. Ong-ongowan
Rosalinda A. Mendoza

Printed in the Philippines by _____

Department of Education – Region 4A CALABARZON

Office Address: Gate 2 Karangalan Village, Brgy. San Isidro, Cainta, Rizal
Telefax: 02-8682-5773/8684-4914/8647-7487
E-mail Address: lrm.d.calabarzon@deped.gov.ph

Senior High School

Earth and Life Science

Quarter 2 – Module 5:

Benefits of Genetically Modified Organisms

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.



What I Need to Know

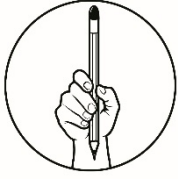
This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module has one lesson:

- Lesson 1 – Benefits of Genetic Engineering

After going through this module, you are expected to:

1. classify the situation given whether as a benefit or a risk in using GMO
2. express one's perception in the use of GMO



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What do you call the technique where there is transfer of genes from one species to a different species?
 - A. cloning
 - B. genetic engineering
 - C. inbreeding
 - D. selective breeding
2. What is the other term for genetically modified organism?
 - A. genetically spliced organism
 - B. transgenic organism
 - C. both a and b
 - D. none of a and b
3. What do you call the process of genetic engineering that is aimed at improving health conditions such as in the production of vaccines?
 - A. cloning
 - B. gene splicing
 - C. recombinant DNA technology
 - D. selective breeding
4. What is the term used for the ethical implications and applications of genetic engineering?
 - A. bioethics
 - B. biogenetics
 - C. biogenesis
 - D. biosynthesis
5. What do you call the hybrid of tiger and lion?
 - A. gerlion
 - B. liger
 - C. lioner
 - D. tilion
6. What do you call the transgenic organism that is injected with scorpion venom aimed to kill caterpillars?
 - A. venomous cabbage
 - B. venomous corn
 - C. venomous cotton
 - D. venomous soy
7. What do you call the transgenic organism that contained human protein per litre of milk and found to be more nutritionally balanced?
 - A. transgenic cow
 - B. transgenic goat
 - C. transgenic spider
 - D. transgenic scorpion

8. What transgenic organism can produce a fluorescent protein in its fur?
- A. luminous cat
 - B. luminous cow
 - C. luminous goat
 - D. luminous spider

For numbers 9-15, refer to the following choices.

- A. Statement I is correct**
- B. Statement II is correct**
- C. Statements I and II are correct**
- D. Statements I and II are incorrect**

9. I. Genetically modified plants have created resistance to harmful agents, enhanced product yield, and shown increased adaptability for better survival
II. Recombinant DNA technology has applications in various areas like medicine, focusing on the discoveries of medicine to cure and improve human health and nutrition
10. I. Genetically modified organisms (GMO) are products of recombinant DNA technology
II. Translated organism is another term for genetically modified organisms
11. I. Corn Resistance to insect pests, specifically the European corn borer, through expression of the insecticidal protein Cry1Ab from *Bacillus thuringiensis*
II. Vaccines in Maize Hepatitis B virus surface antigen (HBsAg) produced in transgenic maize induces immune response when injected into mice.
12. I. One of the uses of GMO is the synthesis of synthetic human haemoglobin and erythropoietin.
II. Another use of GMO is the production of human growth hormone which cure blood clotting among arteries.
13. I. Human clotting factors have also been produced in the milk of transgenic cows
II. "Pharm" animals were produced to synthesize pharmaceutical products
14. I. Crops like potato, tomato, soybean and rice are currently being genetically engineered to obtain new strains with better nutritional qualities and increased yield.
II. Angus cow give enhanced milk that can produce silk stronger than steel
15. I. *Escherichia coli* has injected human gene to produce hormone insulin.
II. Liger is hybrid of tiger and lion.

Lesson

1

Benefits of Genetic Engineering

As defined, Genetic Engineering is the processes of changing the DNA in living organisms to create something new. It involves artificial manipulation, modification, and recombination of DNA or other nucleic acid molecules in order to modify an organism or population of organisms.

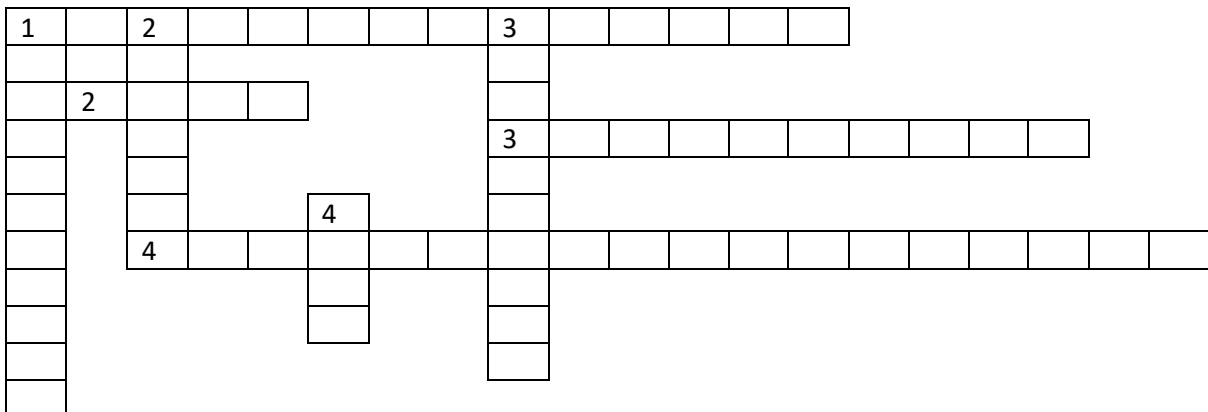
Recombinant DNA technology has applications in various areas like medicine, focusing on the discoveries of medicine to cure and improve human health and nutrition aimed to produce good quality and high quantity crops.



What's In

Activity 1: Guess Me!

Direction. Answer the puzzle by writing your answers in the grid.



DOWN	ACROSS
1. Enzymes that help cut and synthesize DNA nucleotide	1. Technology used to remove and insert genetic sequences from and into other sequences.
2. Process to produce identical organism without using gametes	2. Organisms where the recombinant DNA is introduced; usually bacteria.
3. Practiced to indirectly manipulate genes focusing on the physical traits among organisms.	3. Breeding of organisms that are genetically similar to maintain desired traits.
4. DNA is cut out of one organism and put into another organism	4. Technique used to compare DNA from two or more organisms.

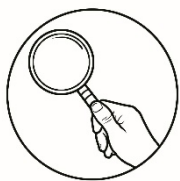


What's New

Activity 2: Transgenic (GM) Organisms

Name the transgenic organism based on the description given by filling up the missing letters.

1. ___ A ___ E	taste of grapes but looks like apple
2. ___ A ___ E I ___ O ___	contained human protein per litre of milk and found to be more nutritionally balance
3. _ E _ O _ OU ___ _ A ___ AG ___	injected with scorpion venom aimed to kill caterpillars
4. B _ N _ N ___ V _ CC _ N ___	can produce virus proteins against hepatitis and cholera
5. E ___ ___ E I ___ IA _ O _ I	insulin gene is injected to bacteria to produce hormone insulin
6. SP _ D _ R G ___ T	spider enhanced milk that can produce silk stronger than steel
7. L _ M _ N ___ S C ___ T	produce a fluorescent protein in its fur
8. L _ G _ R	hybrid of tiger and lion



What is It

The aim of planting genetically modified organisms and its commercial use is to help improve farming methods efficiently and productively. Some of the most common genetically modified crops are soybean, maize, cotton, canola, alfalfa, papaya, eggplant, potato, apple, safflower, pineapple, and sugarcane.

Genetically modified plants have created resistance to harmful agents, enhanced product yield, and shown increased adaptability for better survival. Recombinant technology has been widely used in improving crop varieties. Several transgenic or genetically modified organisms (GMO) have been produced. Genetically Modified Organism are also called transgenic organism since genes are transferred from one organism to another. Recombinant DNA technology is playing

a vital role in improving health conditions by developing new vaccines and pharmaceuticals. The treatment strategies are also improved by developing diagnostic kits, monitoring devices, and new therapeutic approaches. Synthesis of synthetic human insulin and erythropoietin by genetically modified bacteria; human growth hormones which cure stunted growth; tissues plasminogen activator which dissolves blood clots among patients who had heart attack; transgenic pigs used to produced human hemoglobin; human clotting factors have also been produced in the milk of transgenic goats; production of “pharm” animals to synthesize such as pharmaceutical products and production of new types of experimental mutant mice for research purposes.

Production of human insulin in bacteria

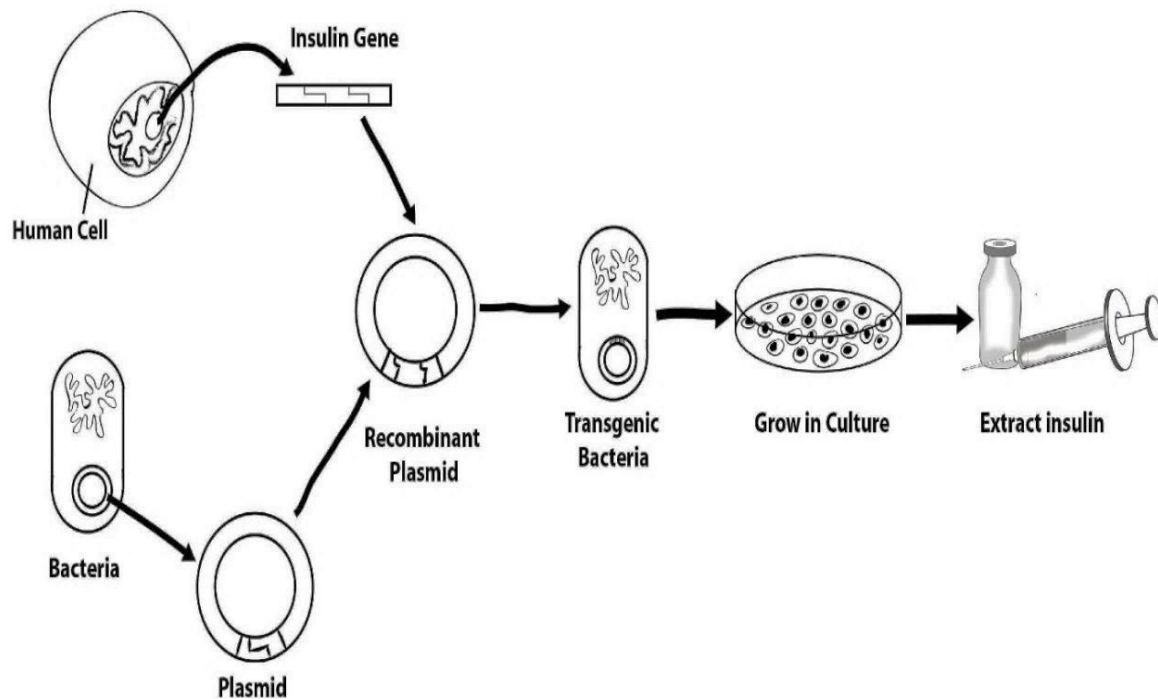


Fig. 1. Production process of human insulin in bacteria

The transfer of human gene to bacteria *Escherichia coli* aims to have a mass production of human insulin to cure diabetes mellitus. Insulin gene is extracted from a human cell and spliced into a plasmid vector before inserted into a bacterial cell. The transgenic bacteria are selected and cultured to be able to increase its number carrying human insulin gene. The bacteria are harvested, purified and packed for human use.

List of genetically modified organisms

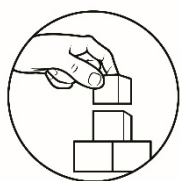
Purpose	Plant	Descriptions
Herbicide tolerance	Soybean	Glyphosate herbicide (Roundup) tolerance conferred by expression of a glyphosate-tolerant form of the plant enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) isolated from the soil bacterium <i>Agrobacterium tumefaciens</i> , strain CP4
Insect resistance	Corn	Resistance to insect pests, specifically the European corn borer, through expression of the insecticidal protein Cry1Ab from <i>Bacillus thuringiensis</i>
Altered fatty acid composition	Canola	High laurate levels achieved by inserting the gene for ACP thioesterase from the California bay tree <i>Umbellularia californica</i>
Virus resistance	Plum	Resistance to plum pox virus conferred by insertion of a coat protein (CP) gene from the virus
Vitamin enrichment	Rice	Three genes for the manufacture of beta-carotene, a precursor to vitamin A, in the endosperm of the rice prevent its removal (from husks) during milling
Vaccines	Tobacco	Hepatitis B virus surface antigen (HBsAg) produced in transgenic tobacco induces immune response when injected into mice
Oral vaccines	Maize	Fusion protein (F) from Newcastle disease virus (NDV) expressed in corn seeds induces an immune response when fed to chickens

<https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/>

Activity 3: Uses of Transgenic (GM) Organisms

Match the following genetically modified organism to its application by writing on the space given.

- | | |
|--|------------------------------|
| _____ 1. Cotton | A. Medicine/ Health Proposes |
| _____ 2. Soy oil | B. Energy sources |
| _____ 3. Corn for livestock feeds | C. Manufacturing products |
| _____ 4. Large quantities of tomatoes | D. Good yield/ Food supply |
| _____ 5. Biodiesel and ethanol from corn | E. High Quality Crops |
| _____ 6. Drugs and genes | |



What's More

Bioethics is the study of controversial ethics brought about by advances in biology and medicine. Bioethics are multidisciplinary. It blends philosophy, theology, history, and law with medicine, nursing, health policy, and the medical humanities.

It is concerned with all the ethical questions that arise in the relationships among life sciences and the cited fields. Bioethics is commonly understood that refers to the ethical implications and application of the health-related life sciences including biotechnology, such as cloning, gene therapy, life extension, human genetic engineering. It promotes critic reflection about ethical conflicts, which are caused by progressing in life science and medicine.

Activity 4: Benefits and Risks of GMO

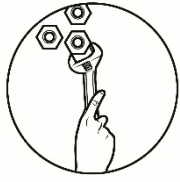
Write letter B if the statement given is a benefit and the letter R if it is a risk from use of genetically modified organisms.

- _____ 1. Crops like potato, tomato, soybean and rice are currently being genetically engineered to obtain new strains with better nutritional qualities and increased yield.
- _____ 2. Genetic engineering in food can be used to produce totally the same or identical substances such as proteins and other food nutrients.
- _____ 3. Positive genetic engineering deals with enhancing the positive traits in an individual like increasing longevity or human capacity while negative genetic engineering deals with the suppression of negative traits in human beings like certain genetic diseases.
- _____ 4. Genetic engineering in food involves the alteration of genes in crops which may have adverse health effects to consumers.
- _____ 5. While increasing the immunity to diseases in plants, the resistance genes may get transferred to the harmful pathogens.
- _____ 6. Genetic engineering can hamper the diversity in organisms.
- _____ 7. The genetic modification of food can be used to increase their medicinal value, thus making edible vaccines available.



What I Have Learned

1. Genetic Engineering is the process of changing the DNA in living organisms to create something new.
2. Genetically modified organism is also called transgenic organism because there was a transfer of genes from one organism to another.
3. Planting GMO and its commercial use improve farming methods efficiently and effectively.
4. Recombinant DNA technology is playing a vital role in improving health conditions by developing new vaccines and pharmaceuticals.
5. Bioethics is the ethical implication and application of the health-related life sciences biotechnology such as cloning, gene therapy, life extension, human genetic engineering.



What I Can Do

Activity 5: What is your stand?

Below are some of the arguments about the use of transgenic organisms. From your own perspective, explain your answer in the questions in not more than 5 sentences.

1. Among the cited examples of GMO, which do you think is the most beneficial?
2. If you are a farmer, would you take the chance of growing crops that are pest resistant? Why or why not?
3. Considering the knowledge gained in genetic engineering, would you try to patronize GMO fruits and vegetables? Why or why not?
4. What is your view of creating or altering genes of an organism in relation to natural creation by God? Explain your answer.
5. Is genetic engineering morally permissible or not?



Assessment

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

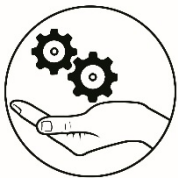
1. What do you call the process of manipulating genes to alter an organism's genetic make-up?
 - A. artificial selection
 - B. cloning
 - C. genetic engineering
 - D. selective breeding
2. Which among the choices is the other term for genetically modified organisms?
 - A. artificially selected organism
 - B. cloned organism
 - C. selected organism
 - D. transgenic organism
3. Which among the choices below is used for improving human health condition by producing vaccines and pharmaceuticals?
 - A. cloning
 - B. gene splicing
 - C. recombinant DNA technology
 - D. selective breeding

4. Which is referred to as the ethical implications and applications of the process of genetic engineering?
 - A. bioethics
 - B. biosystematics
 - C. biogenesis
 - D. biogenetics
5. What do you call the transgenic organism that has the taste of grapes but looks like an apple?
 - A. Aplgrapes
 - B. Aplres
 - C. grapple
 - D. legrapes
6. What is the transgenic organism where insulin gene is injected to produce the hormone insulin?
 - A. *Amoeba proteus*
 - B. *Escherichia coli*
 - C. both and b
 - D. none of a and b
7. What plant is used to produce virus proteins against hepatitis B?
 - A. alfalfa
 - B. corn
 - C. soy beans
 - D. tobacco
8. What animal is used to enhance milk to produce silk stronger than steel?
 - A. cow
 - B. lion
 - C. scorpion
 - D. spider

For numbers 9-15, refer to the following choices.

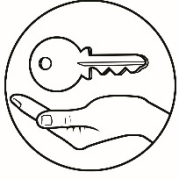
- A. Statement I is correct
 - B. Statement II is correct
 - C. Statements I and II are correct
 - D. Statement I and II are incorrect
9.
 - I. Genetically modified plants have created resistance to harmful agents, enhanced product yield, and shown increased adaptability for better survival.
 - II. Recombinant DNA technology has applications in various areas like medicine, focusing on the discoveries of medicine to cure and improve human health and nutrition
 10.
 - I. Genetically modified organisms (GMO) are products of recombinant DNA technology
 - II. Translated organism is another term for genetically modified organisms

11.
 - I. Corn Resistance to insect pests, specifically the European corn borer, through expression of the insecticidal protein Cry1Ab from *Bacillus thuringiensis*
 - II. Vaccines in Maize Hepatitis B virus surface antigen (HBsAg) produced in transgenic maize induces immune response when injected into mice.
12.
 - I. Synthesis of synthetic human hemoglobin and erythropoietin by genetically modified bacteria
 - II. Human growth hormone cures blood clotting among arteries
13.
 - I. Human clotting factors have also been produced in the milk of transgenic cows
 - II. “Pharm” animals were produced to synthesize pharmaceutical products
14.
 - I. Crops like potato, tomato, soybean and rice are currently being genetically engineered to obtain new strains with better nutritional qualities and increased yield.
 - II. Angus cow give enhanced milk that can produce silk stronger than steel
15.
 - I. *Escherichia coli* has injected human gene to produce hormone insulin.
 - II. Liger is hybrid of tiger and lion.



Additional Activities

1. Watch the video in the website:
<https://www.youtube.com/watch?v=KonUXpTv0SI>
2. Show your learnings in the module by choosing from any of the platforms suggested below to be uploaded in our Google Drive folder named as ELS1stQ
 - an info graphics
 - a one- page essay with maximum 300 words



Answer Key

<p>What's More</p> <p>Activity 4</p> <p>1. B 2. B 3. B 4. R</p> <p>Assessment</p> <p>1. C 2. D 3. C 4. A 5. C 6. B 7. D 8. C</p> <p>9. C 10. A 11. A 12. D 13. B 14. A 15. C</p>	<p>What's New</p> <p>Activity 2</p> <p>1. grapple 2. transgenic cow 3. venomous cabbage 4. banana vaccine 5. <i>Escherichia coli</i> 6. spider goat 7. luminous cat 8. liger</p> <p>What is It</p> <p>Activity 3</p> <p>1. C 2. C 3. C 4. D 5. B 6. A</p>	<p>What I Know</p> <p>1. B 2. B 3. C 4. A 5. B 6. A 7. A 8. A</p> <p>What's In</p> <p>9. C 10. A 11. A 12. D 13. B 14. A 15. C</p> <p>Down</p> <p>1. restriction 2. cloning 3. artificial 4. gene splicing</p> <p>Across</p> <p>1. recombinant DNA 2. host 3. inbreeding 4. gel electrophoresis</p>
--	---	---

References

- Basco-Tiamzon, M.E. Z, Avissar, Y.,Choi J.,Desaix, J., Jurukovski V., Wise, R., Rye, C. "General Biology 2 Senior High School Textbook" Published 2016 Vibal Group, Inc.
- Bayo-ang, R.B., Coronacion, M.L.G., Jorda, A.T., Restubog, A.J. "Earth and Life Science for Senior High School" Published 2016 Educational Resources Corporation
- Commission on Higher Education. Earth and Life Science for Senior High School. C.P. Garcia Ave., Diliman, Quezon City Philippines. Commission on Higher Education, 2016
- Phillips, T. "Genetically modified organisms (GMOs): Transgenic crops and recombinant DNA technology. *Nature Education* 1(1):213" Published 2008 Accessed June 6, 2020
<https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/>
- What is Bioethics? Accessed June 4, 2020 <https://www.bioethics.msu.edu/what-is-bioethics>

For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph