

LESSON 1

THE INFORMATION AGE

LESSON OBJECTIVES

At the end of this lesson, the students should be able to:

- Define Information Age:
- discuss the history of Information Age; and
- Understand the factors that need to be considered in checking website sources.

INTRODUCTION

Highly modernized, automated, data-driven, and technologically advanced-these best describe our society nowadays, as evidenced by how information could be transferred or shared quickly. The different areas of society have been influenced tremendously such as communication, economics, industry, health, and the environment. Despite our gains due to the growing development of information technology, the rapid upgrade of information also has disadvantages. This lesson will discuss the history and impact of technological advancements to society.

Life is accompanied by endless transmission of information that takes place within and outside the human body. According to Webster's Encyclopedic Unabridged Dictionary, information is "knowledge communicated or obtained concerning. Hence, information is a very important tool for survival, specific fact or circumstance."

The Information Age is defined as a "period starting in the last quarter of the 20th century when information became effortlessly accessible through publications and through the management of information by computers and computer networks" (Vocabulary.com, n.d.). The means of conveying symbolic information (e.g., writing, math, other codes) among humans has evolved with increasing speed. The Information Age is also called the Digital Age and the New Media Age because it was associated with the development of computers

According to James R. Messenger who proposed the theory of Information Age in 1982, "the Information Age is a true new age based upon the interconnection of computers via telecommunications, w these information systems operating on both a real-time and as-needed basis. Furthermore, the primary factors driving this new age forward are convenience and user-friendliness which, in turn, will create user dependence."

History

The table below traces the history and emergence of the Information Age (United States American History, n.d.).

Table 1. Timeline of the Information Age

YEAR	EVENT
300 BC	Sumerian writing system used pictographs to represent words
2900 BC	Beginnings of Egyptian hieroglyphic writing
1300BC	Tortoise shell and oracle bone writing were used
500 BC	Papyrus roll was used
220 BC	Chinese small seal writing was developed
100 AD	Book (parchment codex)
105 AD	Woodblock printing and paper was invented by the Chinese
1455	Johannes Gutenberg invented the printing press using movable metal type
1755	Samuel Johnson's dictionary standardized English spelling
1802	- the Library of Congress was established - Invention of the carbon arc lamp
1824	Research on persistence of vision published
1830s	- First viable design for a digital computer - Augusta Lady Byron writes the world's first computer program
1837	Invention of the telegraph in Great Britain and the United States
1861	Motion pictures were projected onto a screen
1876	Dewey Decimal system was introduced
1877	Eadweard Muybridge demonstrated high-speed photograph
1899	First magnetic recording were released
1902	Motion picture special effects were used
1906	Lee DeForest invented the electronic amplifying tube (triode)
1923	Television camera tube was invented by Zvorkyn
1926	First practical sound movie
1939	Regularly scheduled television broadcasting began in the US
1940s	Beginnings of information science as a discipline
1945	Vannevar Bush foresaw the invention of hypertext
1946	ENIAC computer was developed
1948	Birth of field-of-information theory proposed by Claude E. Shannon
1957	Planar transistor was developed by Jean Hoerni

1958	First integral circuit
1960s	Library of Congress developed LC MARC (machine-readable code)
1969	UNIX operating system was developed, which could handle multitasking
1971	Intel introduced the first microprocessor chip
1972	Optical laserdisc was developed by Philips and MCA
1974	MCA and Philips agreed on a standard videodisc encoding format
1975	Altair Microcomputer Kit was released: first personal computer for the public
1977	RadioShack introduced the first complete personal computer
1984	Apple Macintosh computer was introduced
Mid 1980s	Artificial intelligence was separated from information science
1987	HyperCard was developed by Bill Atkinson recipe box metaphor
1991	Four hundred fifty complete works of literature on one CD-ROM was released
January 1997	KSA (encryption and network security software) Internet security code cracked for a 48-bit number

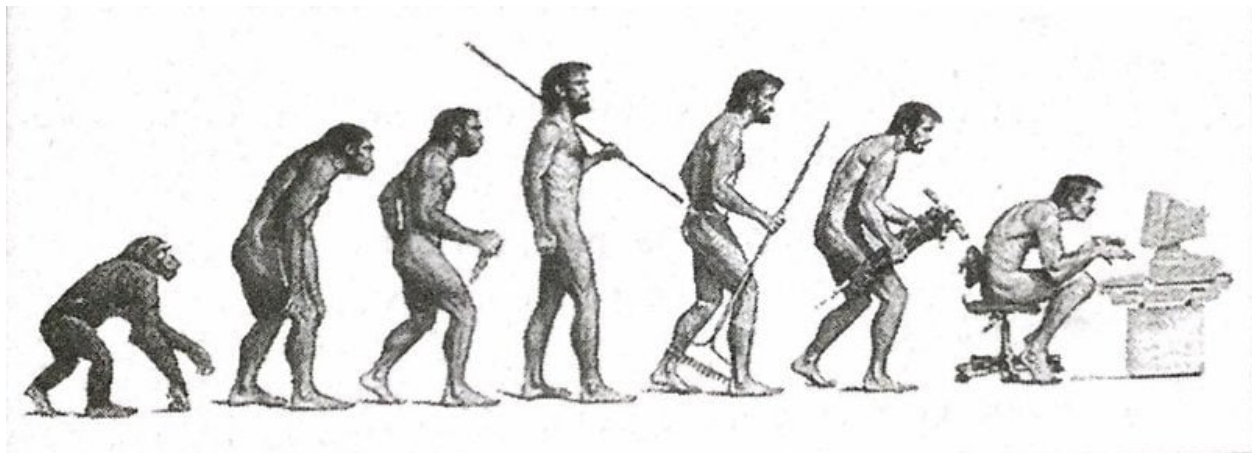


Figure 7. Evolution of Man and Information

As man evolved, information and its dissemination has also evolved in many ways. Eventually, we no longer kept them to ourselves; instead, we share them and manage them in different means. Information got ahead of us. It started to grow at a rate we were unprepared to handle. Because of the abundance of information, it was difficult to collect and manage them starting in the 1960s and 1970s.

During the 1980s, real angst set in. Richard Wurman called it "Information Anxiety." In the 1990s, information became the currency in the business world. Information was the preferred medium of exchange and the information managers served as information officers. In the present generation, there is no doubt that information has turned out to be a commodity, an overdeveloped product, mass-produced, and unspecialized. Soon, we become overloaded with it. Different authors have diverse, contrasting ideas that on information the evolution is of the Information Age. In spite of this, we can live. One thing is for sure, the information Age will continue to move forward and far greater than our minds could imagine.

In his article "Truths of the Information Age" (n.d.), Robert Harris detailed some facts on the Information Age.

1. Information must compete. There is a need for information to stand out and be recognized in the increasing clutter.
2. Newer is equated with truer. We forgot the truth that any fact or value can endure.
3. Selection is a viewpoint. Choose multiple sources for your information if you want to receive a more balanced view of reality.
4. The media sells what the culture buys. In other words, information is driven by cultural priorities.
5. The early word gets the perm. The first media channel to expose an issue often defines the context, terms, and attitudes surrounding it.
6. You are what you eat and so is your brain. Do not draw conclusions unless all ideas and information are presented to you.
7. Anything in great demand will be counterfeited. The demand for incredible knowledge, scandals, and secrets is ever-present; hence, many events are fabricated by tabloids, publicists, or other agents of information fraud.
8. Ideas are seen as controversial. It is almost certainly impossible to make any assertion that will not find some supporters and some detractors.
9. Undead information walks ever on. Rumors, lies, disinformation, and gossips never truly die down. They persist and continue to circulate.
10. Media presence creates the story. People behave much differently from the way they would if being filmed when the media are present, especially film news or television media.
11. The medium selects the message. Television is mainly pictorial, partially aural, and slightly textual, so visual stories are emphasized: fires, chases, and disasters.
12. The whole truth is a pursuit. The information that reaches us is usually selected, verbally charged, filtered, slanted, and sometimes, fabricated. What is neglected is often even more important than what is included.

Computer

Computers are among the most important contributions of advances in the Information Age to society. A computer is an electronic device that stores and processes data (information). It runs on a program that contains the exact, step-by-step directions to solve a problem (UShistory.org, 2017).

Types of Computer

Computers are associated with numerous terms and descriptions. Most people suggest the dimensions, intended use, or the computer's power. While the term "computer" can apply to virtually any device that has a microprocessor in it, most people think of a computer as a device that receives input from the user through a mouse (hand-guided directions tool) or keyboard, processes it in some fashion, and presents the result on a screen.

1. Personal Computer (PC)

It is a single-user instrument. PCs were first known as microcomputers since they were a complete computer but built on a smaller scale than the enormous systems operated by most businesses.

2. Desktop Computer

It is described as a PC that is not designed for portability. The assumption with a desktop is that it will be set up in a permanent spot. A workstation is simply a desktop computer that has a more powerful processor, additional memory, and enhanced capabilities for performing special group of tasks, as 3D graphics or game development. Most desktops offer storage, power, and versatility than their portable versions (UShistory.org, 2017).

3. Laptops

These are portable computers that integrate the essentials of a desktop computer in a battery-powered package, which are somewhat larger than a typical hardcover book. They are commonly called notebooks.

4. Personal Digital Assistants (PDAS)

These are tightly integrated computers that usually have no keyboards but rely on a touch screen for user input. PDAs are typically smaller than a paperback, lightweight, and battery powered (UShistory.org, 2017).

5. Server

It refers to a computer that has been improved to provide network services to other computers. Servers usually boast powerful processors, tons of memory, and large hard drives (UShistory.org, 2017).

6. Mainframes

These are huge computer systems that can fill an entire room. They are used especially by large firms to describe the large, expensive machines that process millions of transactions every day. The term "mainframe" has been replaced by enterprise server. Although some supercomputers are single computer systems, most comprise multiple, high-performance, parallel computers working as a single system (USHistory.org, 2017).

7. Wearable Computers

They involve mobile cell phones, watches, and cell phones materials that are usually integrated into perform common computer application such as databases, email, multimedia, and schedulers (USHistory.org, 2017).

The World Wide Web (Internet)

Several historians trace the origin of the Internet to Claude E. Shannon, an American Mathematician who was considered as "29 of Information Theory." He worked at Bell Laboratories and at age 4 he published a paper proposing that information can be quantitatively encoded as a sequence of ones and zeroes.

The internet is a worldwide system of interconnected network that facilitate data transmission among innumerable computers. It developed during the 1970s by the Department of Defense. In case of an attack, military advisers suggested the advantage of being able to operate on one computer from another terminal. In the early days, the Internet was used mainly by scientists to communicate with other scientists. The Internet remained under government control until 1984 (Rouse, 2014).

One early problem faced by Internet users was speed. Phone lines could only transmit information at a limited rate. The development of fiber-optic cables allowed for billions of bits of information to be received every minute. Companies like Intel developed faster microprocessors so personal computers could process the incoming signals at a more rapid rate (USHistory.org, 2017).

Sergey Brin and Larry Page, directors of a Stanford research project, built a search engine that listed results to reflect page popularity when they determined that the most popular result would frequently be the most usable. After talking with family, friends, and other investors into contributing \$1 million, the researchers launched their company in 1998. Google is now the world's most popular search engine, accepting more than 200 million queries daily.

Back then, new forms of communication were also introduced. Electronic mail, or email, was a suitable way to send a message to fellow workers, business partners, or friends. Messages could be sent and received at the convenience of the individual. A letter that took several days to be read in minutes. Internet service providers like America Online and CompuServe set up electronic chat rooms. These were open areas of cyberspace where interested parties could join in a conversation with perfect strangers. "Surfing the net" became a pastime in and of itself (USHistory.org, 2017).

Consequently, companies whose businesses are built on digitized information have become valuable and powerful in a relatively short period of time; the current Information Age has spawned its own breed of wealthy influential brokers, from Microsoft's Bill Gates to Apples Steve Jobs to Facebook's Mark Zuckerberg.

Critics charged that the Internet created a technological divide that creased the gap between the members of the higher class and lower class of society. Those who could not afford a computer or a monthly access fee were denied these possibilities. Many decried the impersonal nature of electronic communication compared to a telephone call or a handwritten letter.

On one hand, the unregulated and loose nature of the Internet allowed pornography to be broadcast to millions of homes. Protecting children from these influences or even from meeting violent predators would prove to be difficult. Nowadays, crimes in various forms are rampant because of the use of social media. Cyber bullying is an issue that poses alarm worldwide. Consequently, we need to be aware of the possible harm and damage due to abuse of these advances in the Information Age.

Applications of Computers in Science and Research

One of the significant applications of computers for science and research is evident in the field of bioinformatics. Bioinformatics is the application of information technology to store, organize, and analyze vast amount of biological data which is available in the form of sequences and structures of proteins-the building blocks of organisms and nucleic acids-the information carrier (Madan, n.d.).

Early interest in bioinformatics was established because of a need to create databases of biological sequences. The human brain cannot store all the genetic sequences of organisms and this huge amount of data can only be stored, analyzed, and be used efficiently with the use of computers.

While the initial databases of protein sequences were maintained at individual laboratories, the development of a consolidate to known as SWISS-PROT protein sequence database, was initiated in 1968. It now has about 70,000 protein sequences from more than o organisms, a small fraction of all known organisms. The enormous variety of divergent data resources is now available for study and research academic institutions and industries. These are made available as public domain information in the larger interest of research community the Internet (www.ncbi.nlm.nih.gov) and CD-ROMs (on request from www.rcsb.org). These databases are constantly updated with additional entries (Madan, n.d.).

Computers and software tools are widely used for generating these databases and to identify the function of proteins, model the structure of proteins, determine the coding (useful) regions of nucleic acid sequences, find suitable drug compounds from a large pool, and optimize the drug development process by predicting possible targets. Some of the software tools which are handy in the analysis include: BLAST (used for comparing sequences); Annotator (an interactive genome analysis tool); and GeneFinder (tool to identify coding regions and splice sites) (Madan, n.d.).

The sequence information generated by the human genome research, initiated in 1988, has now been stored as a primary information source for future applications in medicine. The available data is so huge that if compiled in books, the data would run into 200 volumes of 1,000 pages each and reading alone (ignoring understanding factor) would require 26 years working around the clock. For a population of about five billion human beings with two individuals differing in three million bases, the genomic sequence difference database would have about 15,000,000 billion entries. The present challenge to handle such huge volume of data is to improve database design, develop software for database access, and manipulation and devise data-entry procedures to compensate for the varied computer procedures and systems used in different laboratories. The much-celebrated complete human genome sequence which was formally announced on the 26th of June 2000 involved more than 500×10^{18} (500 million trillion) calculations during the process of assembling the sequences alone. This can be considered as the biggest exercise in the history of computational biology (Madan, n.d.).

Moreover, from the pharmaceutical industry's point of view, bioinformatics is the key to rational drug ds and in identifying number of trials in the screening of drug compounds and in identifying potential drug targets for a particular disease using high-power computing workstations and software like Insight. This profound application of bioinformatics in genome sequence has led to a new area in pharmacology- pharmacogenomics, where potential targets for drug development are hypothesized from the genome sequences. Molecular modeling, which requires a lot of calculations, has become faster due to the advances in computer processors and its architecture (Madan, n.d.).

How to Check the Reliability of Web Sources

The Internet contains a vast collection of highly valuable information but it may also contain unreliable, biased information that mislead people. The following guidelines can help us check the reliability of web sources that we gather. It is noteworthy to consider and apply the following guidelines to avoid misinformation. (Lee College Library, n.d.)

1. Who is the author of the article/site?
 - How to find out?

Look for an "About" or "More About the Author" link at the top, bottom, or sidebar of the webpage. Some pages will have a corporate author rather than a single person as an author. If no information about the author(s) of the page is provided, be suspicious.

- ✓ Does the author provide his or her credentials?
- ✓ What type of expertise does he or she have on the subject he or she is writing about? Does he or she indicate what his or her education is?
- ✓ What type of experience does he or she have? Should you trust his or her knowledge of the subject?

Try searching on the Internet for information about the author.

- ✓ What kinds of websites are associated with the author's name? Is he or she affiliated with any educational institution?
 - ✓ Do commercial sites come up? Do the websites associated with the author give you any clues to particular biases the author might have?
2. Who published the site?
- How to find out?
 - ✓ Look at the domain name of the website that will tell you who is hosting the site. For instance, the Lee College Library website is: <http://www.lee.edu/library>. The domain name is "lee.edu." This tells you that the library website is hosted by Lee College.
 - ✓ Search the domain name at <http://www.whois.sc/>. The site provides information about the owners of registered domain names. What is the organization's main purpose? Check the organization's main website, if it has one. Is it educational? Commercial? Is it a reputable organization?
 - ✓ Do not ignore the suffix on the domain name (the three-letter part that comes after the "."). The suffix is usually (but not always) descriptive of what type of entity hosts the website. Keep in mind that it is possible for sites to obtain suffixes that are misleading. Here are some examples:
 - .edu=educational
 - .com=Commercial
 - .mil=military
 - .gov=government
 - .org=nonprofit
3. What is the main purpose of the site? Why did the author write it and why did the publisher post it?
- To sell a product?
 - As a personal hobby?
 - As public service?
 - To further scholarship on a topic?
 - To provide general information on a topic?
 - To persuade you of a particular point of view?
4. Who is the intended audience?
- Scholars or the general public?
 - Which age group is it written for?
 - Is it aimed at people from a particular geographic area?
 - Is it aimed at members of a particular profession or with specific training?

5. What is the quality of information provided on the website? 5.
 - Timeliness: When was the website first published? Is it regularly updated? Check for dates at the bottom of each page on the site.
 - Does the author cite sources? Just as in print sources, web sources that cite their sources are considered more reliable.
 - What type of other sites does the website link to? Are they reputable sites?
 - What types of sites link to the website you are evaluating? Is the website being cited by others?

Examples of Useful and Reliable Web Sources

1. AFA e-Newsletter (Alzheimer's Foundation of America newsletter)
2. American Memory - the Library of Congress historical digital collection.
3. Bartleby.com Great Books Online a collection of free e-books including fictions, nonfictions, references, and verses.
4. Chronicling America - search and view pages from American newspapers from 1880-1922.
5. Cyber Bullying - a free collection of e-books from ebrary plus additional reports and documents to help better understand, prevent and take action against this growing concern.
6. Drug information websites: .
 - National Library of Medicine's Medline Plus
 - Drugs.com
 - PDRhealth
7. Global Gateway: World Culture & Resources (from the Library of Congress)
8. Google Books
9. Google Scholar.com
10. History sites with primary documents:
 - AMDOCS: Documents for the study of American history
 - Avalon Project: Documents in Law, History and Diplomacy (Yale Law School)
 - Internet Modern History Sourcebook: Colonial Latin America
 - Teacher Oz's Kingdom of History
11. Illinois Digital Archives- the Illinois State Library working with libraries, museums, and historical societies in Illinois provides this collection of materials related to Illinois history.
12. Internet Archive a digital library of Internet sites and other cultural artifacts in digital form.
13. Internet Archive for CARLI digitized resources
14. Internet Public Library
15. ip12 a merger of Librarians' Internet Index and Internet Public Library. Special interest may include the "Literary Criticisms" page which can be found after clicking on the "Special Collections" link.
16. Librarians' Internet Index
17. Making of America a digital library of primary sources in American social history.
18. Maps from the University of Texas at Austin collection. Includes historical and thematic maps.
19. NationMaster a massive central data source and a handy way to graphically compare nations. It is a vast compilation of data from such sources as the CIA World Factbook, UN, and OECD.

20. Nursing sites:

- AHRQ (www.ahrq.gov)
- National Guidelines Clearinghouse (www.guideline.gov)
- PubMed (www.nlm.nih.gov)

21. Project Gutenberg - first and largest single collection of free electronic books with currently over 20,000 e-books available.

22. Shmoop - literature, US history, and poetry information ten primarily by PhD and masters students from top universities like Stanford, Berkeley, Harvard, and Yale.

23. StateMaster - a unique statistical database which allows you research and compare a multitude of different data on US states using various primary sources such as the US Census Bureau, the FBI, and the National Center for Educational Statistics. It uses visualization technology like pie charts, maps, graphs, and scatter plots to provide data

24. Virtual Reference - selected web resources compiled by the Library of Congress.

One can also visit the university library and seek help from librarians as they are knowledgeable and the library has a rich collection of online library resources that are very useful for academic and research purposes.

SUMMARY

Nowadays, information could be shared or transferred quickly. People are becoming more interested in sharing information about themselves. Various aspects of our society are also being influenced by the Information Age especially communication, economics, industry, health, and the environment. The rapid upgrade of information poses both positive and negative impacts to our society. Therefore, we need to carefully check our motives before disseminating information and we also need to verify information before believing them and using and sharing them. We should share information that could help improve our lives and others.

LESSON 2

BIODIVERSITY AND THE HEALTHY

SOCIETY

LESSON OBJECTIVES

At the end of this lesson, the students should be able to:

- determine the interrelatedness of society, environment, and health;
- create a diagram that would show the relatedness of species in forming up a diverse and healthy society without compromising one another; and
- identify everyday tasks and evaluate whether they contribute the wellness and health of biodiversity and society or not.

INTRODUCTION

Decrease in biodiversity is eminent worldwide. Vertebrates fell to 60% from the 1970s due to human causes. It is projected that by 2020, wildlife decline will be 67% of the present number. The World Wide Fund for Nature and Zoological Society of London reported an annual decrease in wildlife by 2%. A major cause is human population which has doubled in number since 1960 to 7.4 billion. Humans have industrialized the natural habitat of wildlife as well as marine life. Leaving these creatures with no place to live would eventually cause their deaths. Marco Lambertini, the General Director of WWF International, described that the disappearance of wildlife is at an unprecedented rate. Earth might enter the sixth mass extinction event according to experts. Mass extinction is described as the disappearance of species at a rate of 1,000 faster than usual. Moreover, the disappearance of species in a certain environment causes an imbalance in the ecosystem, producing more chaotic changes that harm the entire ecosystem (Inquirer.net, 2016).

This is but a pressing statement for people to know more about the importance of our diverse environment, and how human activities can either contribute to its growth or destruction. There is a growing importance of studying how society, environment, and health is linked to each other, that if human beings fail to recognize the needs of one of those components, the other remaining components can be affected and compromised. Thus, it is timely to know about the pressing effects of species being extinct and that of our ecosystem being imbalanced.

Biodiversity and Ecosystem

Biodiversity is defined as the vast variety of life forms in the entire Earth. It encompasses all kinds of life forms, from the single-celled organisms to the largest multi-celled organisms. Its definition is in the structural and functional perspective and not as individual species.

Another definition of biodiversity is "the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems. Biodiversity is the source of the essential goods and ecological services that constitute the source of life for all and it has direct consumptive value in food, agriculture, medicine, and in industry." (Villaggio Globale, 2009)

Understanding biodiversity within the concept of ecosystem needs a thorough study on the relationship of the biotic, the living organisms and the abiotic, nonliving organisms. Interdisciplinary approach is needed to study the ecosystem. Biodiversity plays a major role in this natural dynamics. For example, a large number of golden snails in a certain area of a rice field can help predict a low production of rice harvest, since eggs of the golden snails are considered pest for rice plant. On a positive view, the larger number of different species in a certain area can be a predictor of sustainable life in that area. Sustainability of the ecosystem ensures a better survival rate against any natural disaster. Therefore, we, as human inhabitants of the ecosystem, must preserve and conserve the biodiversity of all creatures.

In simpler terms, it is true that people will always depend on biodiversity on the wholeness of our being and in our everyday lives. More so, our health will ultimately depend upon the products and services that we acquire from the ecosystem. Somehow, there are ways and processes in the ecosystem that are not apparent nor appreciated by us, human beings. Think about the need to drink clean and fresh water, the need to eat healthy vegetables and food, or the need of man to transport which makes him rely on fuel. All of these are human needs that are answered and provided by our ecosystem. Thus, if we fail to keep the process or taking care of the ecosystem, it is us who are actually putting our lives at risk. Significant decline in biodiversity has direct human impact when ecosystem in its insufficiency can no longer provide the physical as well as social needs of human beings. Indirectly, changes in the ecosystem affect livelihood, income, and on occasion, may even cause political conflict (WHO, n.d.).

Changes in Biodiversity

Alteration in any system could bring varied effects. A change in biodiversity could have erratic effects not only in wildlife or marine life but also in human beings. For example, humans inhabiting the forest would disturb the natural order of life. Trees and plants would be affected in the land-clearing operations where the houses would be built. The animals, insects, and all types of life forms in the cleared area would either be displaced or most likely be killed. The loss of these life forms could affect the entire ecosystem governing that environment. The food chain might be damaged. From this, we can clearly infer that when our ecosystem is not well taken care of, biodiversity encounters changes that may impact human health on such different levels.

Threats to Biodiversity

There are major threats to biodiversity that were identified by the United Nations' Environment Programme (WHO, n.d.). These are the following.

1. *Habitat loss and destruction.* Major contributing factor is the inhabitation of human beings and the use of land for economic gains.
2. *Alterations in ecosystem composition.* Alterations and sudden changes, either within species groups or within the environment. Could begin to change entire ecosystems. Alterations are a critical factor contributing to species and habitat loss
3. *Over exploitation.* Over-hunting, overfishing, or over-collecting of species can quickly lead to its decline. Changing consumption patterns of humans is often cited as the key reason in unsustainable exploitation of natural resources.
4. *Pollution and contamination.* Biological systems respond slowly to changes in their surrounding environment. Pollution and Contamination cause irreversible damage to species and varieties.
5. *Global climate change.* Both climate variability and climate change cause biodiversity loss. Species and populations may be lost permanently if they are not provided with enough time to adapt to changing climatic conditions.

Consequences of Biodiversity Loss

Even with the improvement of technology and science at present, we still have a lot to learn about biodiversity, more so about the consequences of biodiversity loss. However, the basic concept about biodiversity loss was from Charles Darwin and Alfred Russel Wallace.

Intact ecosystems function best since the organisms composing them are specialized to function in that ecosystem to capture, transfer, utilize and, ultimately, lose both energy and nutrients. The particular species making up an ecosystem determine its productivity, affect nutrient cycles and soil contents, and influence environmental conditions such as water cycles, weather patterns, climate, and other nonbiotic aspects. The loss of biodiversity has many consequences that we understand, and many that we do not. It is apparent that humankind is willing to sustain a great deal of biodiversity loss if there are concomitant benefits to society; we hope they are net benefits. In many cases, the benefits seem to accrue to a few individuals only, with net societal loss. However, it is extremely difficult to estimate the future costs of losses in biodiversity or of environmental damage (Rainforest Conservation Fund, 2017).

As stated by Tilman, "The Earth will retain its most striking feature, its biodiversity, only if humans have the prescience to do so. This will occur, it seems, only if we realize the extent to which we use biodiversity (Rainforest Conservation Fund, 2017).

Nutritional Impact of Biodiversity

According to the World Health Organization, biodiversity is a vital element of a human being's nutrition because of its influence to food production. Biodiversity is a major factor that contributes to Sustainable food production for human beings. A society or a population must have access to a sufficient variety of nutritious food as it is a determinant of their health as human beings.

Nutrition and biodiversity are linked at many Levels: the ecosystem, with food production as an ecosystem service, the species in ecosystem; and the genetic diversity within species. Nutritional composition between foods and among varieties/cultivars/breeds of the same food can differ dramatically, affecting micronutrient availability in the diet. Healthy local diets, with adequate average levels of nutrients intake, necessitates maintenance of high biodiversity levels. Intensified and enhanced food production through irrigation, use of fertilizer, plant protection (pesticides), or the introduction of crop varieties and cropping patterns affect biodiversity and thus impact global nutritional status and human health. Habitat simplification, species loss, and species succession often enhance communities, vulnerabilities as a function of environmental receptivity to ill health (WHO, 2007).

Health, Biology, and Biodiversity

Almost all living organisms are dependent to their environment to live and reproduce. Basic needs of living organisms such as air, water, food, and habitat are provided by its environment. The evolution of human beings was due to the improved access to these basic needs. Advances in agriculture, sanitation, water treatment, and hygiene have had a far greater impact on human health than medical technology.

Although the environment sustains human life, it can also cause diseases. Lack of basic necessities is a significant cause of human mortality. Environmental hazards increase the risk of cancer, heart disease, asthma, and many other illnesses. These hazards can be physical, such as pollution, toxic chemicals and food contaminants, or they can be social, such as dangerous work, poor housing conditions, urban sprawl, and poverty. Unsafe drinking water and poor sanitation and hygiene are responsible for meningitis, and gastritis. In 2015, approximately 350,000 children under related to unsafe drinking water and approximately 1.8 billion people used drinking water contaminated with feces. More than two billion people lacked access to basic sanitation.

The interrelation between human health and biological diversity is considerable and complex, with the current biodiversity loss at unprecedented rates, the delicate balance between human health and biological diversity is at risk.

Environment-Related illnesses

Some human illnesses that are found to be related with its environment include Parkinson's disease, heart disease, cancer, chronic obstructive pulmonary disease, asthma, diabetes, obesity, occupational injuries, dysentery, arthritis, malaria, and depression.

By contrast, activities that promote health and extend human life could have adverse environmental effects. For example, food production causes environmental damage from pesticides and fertilizers, soil salinization, waste produced by livestock, carbon emissions from food manufacturing and transportation, deforestation, and overfishing. Health care facilities also have adverse environmental impacts. Hospitals use large quantities of electricity and fossil fuels and produce medical wastes. To prevent some diseases, it may be necessary to alter the environment. For example, malaria was eradicated in the United States and other developed nations in the 1940s and 50s as a result of draining wetlands and spraying DDT to kill mosquitoes. A reduction in mortality from starvation or disease can lead to overpopulation, which stresses the environment in many different ways-increasing use of fossil fuels, clearing of land, generating pollution and waste, and so on (Rensik & Portier, 2017).

Interestingly, according to experts, climate change could also have a serious impact on human health and could deteriorate farming system and reduce nutrients in some foods. In this case, biodiversity increases resilience, thus helping adjust to new environmental conditions. Safeguarding of coral reefs, for instance, is essential to reduce the risk of as this extraordinary ecosystem can reduce wave energy by 97%, thus protecting over 100 million people all over the world.

Relationships between human health and the environment raise many ethical, social, and legal dilemmas by forcing people to choose among competing values. Many of the issues at the intersection of health and the environment have to do with managing benefits and risks. For example, pesticides play an important role in increasing crop yields, but they can also pose hazards to human health and the environment. Alternatives to pesticide use create trade-offs in health. The extreme action of stopping all pesticide uses could significantly reduce agricultural productivity, leading to food shortages and increased food prices which would, in turn, increase starvation in some parts of the world. Public health authorities have opted to regulate the use of pesticides to enhance food production while minimizing

damage to the environment and human health. Energy production and use help sustain human life, but it can also pose hazards to human health and the environment, such as air and water pollution, oil spills, and destruction of habitats (Rensik & Portier, 2017).

No issue demands greater care in balancing benefits and risks than global warming. A significant percentage of global climate change is due to the human production of greenhouse gases. Climate change is likely to cause tremendous harm to the environment and human health, but taking steps to drastically reduce greenhouse gases could have adverse consequences for global, national, and local economies. For example, greatly increasing taxes on fossil fuels would encourage greater fuel efficiency and lower carbon dioxide emissions, but it would also increase the price of transportation, which would lead to widespread inflation and reduced consumer spending power. Managing benefits and risks also raises social justice concerns. In general, people with lower socio-economic status have greater exposure to certain harmful environmental conditions in their homes or at work, such as lead, mercury, pesticides, toxic chemicals, or air and water pollution. Communities and nations should wisely choose a site for a factory, a power plant, or Waste dump, or regulating safety in the workplace to minimize impact to the society. The decision-making process should be fair, open and democratic, so that people who will be affected by environment risk have a voice in these deliberations and can make their concerns known (Rensik & Portier, 2017)

When drafting and implementing environmental health regulations, it is important to consider vulnerable subpopulations. A vulnerable subpopulation is a group with an increased susceptibility to effects or an environmental risk factor, due to their age, genetics, health status, or some other condition. If an environmental regulation is designed to protect average members of the population, it may fail to adequately protect vulnerable subpopulations. Justice demands that we take a people who are vulnerable. However, almost everyone in the population has an above-average susceptibility to at least one environmental risk factor. Since providing additional protection to everyone would be costly and impractical, protections must be meted out carefully and the populations who are vulnerable to a particular environmental risk factor must be defined clearly (Rensik & Portier, 2017).

In addition to this, various public health strategies pit the rights of individuals against the good of society, such as mandatory treatment, vaccination, or diagnostic testing; isolation and quarantine; and disease surveillance. The owner of a coal-burning power plant must deal with many laws concerning the operation of the plant, workplace safety, and carbon emissions. A developer who plans to build 150 new homes with land he has purchased may also have to deal with laws concerning storm drainage, water and sewage lines, gas lines, sidewalks, and so on. Restrictions on property rights are justified to protect human health and the environment. However, opponents of these restrictions argue that they are often excessive or not adequately supported by scientific evidence (Rensik & Portier, 2017).

Human rights issues also come up with research on environmental health that involves human subjects. For such research to be ethical, human subjects must give consent, and great care must be taken to ensure that they understand that they can opt out of the research project. Since the late 1990s, some pesticide companies have tested their products on human subjects to gather data to submit to the government for regulatory purposes. Some commentators charge that these experiments are unethical

because they place people at unacceptably high risk without a clear benefit to society. Others have argued that the experiments, if properly designed and implemented, could produce important benefits to society by providing useful knowledge about the effects of pesticides that lead to stronger regulations (Rensik & Portier, 201).

With these in mind, a mitigating plan and a workable plan of action should be studied in order to not compromise biodiversity, while at the same time, promote good health among the society.

SUMMARY

Most of the time, it may seem impossible to really value species singly or in a detailed manner. But we have to consider the entire Earth as a single unit. A loss of single-celled species or a family of wild grass can have adverse effects in the entire biosphere. Biodiversity seen in macro level seems to be still vast and rich, yet if we look at it in micro- level, per species, we have lost too much. Eventually, in the near future, this biodiversity loss will have a great negative effect especially to us humans "The value of biodiversity is the value of everything" (Rainforest Conservation Fund, n.d.).

We must recognize the value of the organisms with which we share the planet. As Costanza et al. (1997) put it, "We must begin to give the natural capital stock that produces these services adequate weight in the decision-making process, otherwise, current and continued future human welfare may drastically suffer many ecosystem services are literally irreplaceable." We do not and probably cannot, ever evaluate such services adequately, but we can value the ecosystems of the world appropriately (Rainforest Conservation Fund, n.d.).

LESSON 3

GENETICALLY MODIFIED ORGANISMS:

SCIENCE, HEALTH, AND POLITICS

LESSON OBJECTIVES

At the end of this lesson, the students should be able to:

- identify issues on genetically modified organisms (GMOs);
- discuss different implications and impact of GMOs; and
- create a research paper on the impact of GMOs in the Philippine context.

INTRODUCTION

In 2001, Rosalie Ellasus, a former overseas Filipino worker in Singapore turned farmer, attended the Integrated Pest Management Farmers Field School and was introduced to Bt Corn, a genetically modified corn that is resistant to the destructive Asian corn borer. Ms. Ellasus volunteered for demo-testing in her field. Bt Corn yielded 7.2 tons per acre as compared to a regular yield of 4.2 tons per hectare. No

insecticide spraying was needed. This is one of the success stories of genetically modified organisms (GMOs) (Ongkiko, 2016).

Genetic engineering has been with the human society since selective breeding was introduced to humankind and when animals were domesticated. Yet, the process of genetic alterations is all but natural.

It was in 1951 that the term genetic engineering was coined by Jack Williamson, author of the science fiction novel *Dragon 5 Island* (Stableford 2004). This was years before actual research findings on the DNA's role in heredity and its structure, the double-helix of Watson and Crick, were published. Through continuous search and development, genetic engineering no longer stayed in science fiction novel. It became a reality in science laboratories. The general process of genetic engineering is the deliberate manipulation of the organism's genes, where it may involve transfer of genes from other organism.

An antibiotic-resistant *E. coli* bacteria was created in 1973. To date, there are ongoing researches on GMOs such as using genetically modified male mosquitoes as pest control over female mosquito carriers of Zika virus.

However, despite the many possibilities of creating solutions for problems and opening doors for innovations, genetic engineering faces much opposition. Opponents raise ethical, social, and environmental issues related to genetic engineering and its GMOs.

This lesson will present the existence of genetic engineering, specifically GMOs in the different areas of life, the impact to humankind, and the controversies that surround them.

Genetically Modified Organism

Genetically modified organism (GMO) is the term used for an organism created through genetic engineering. The World Health Organization (WHO, 2014) defines GMO as an "organism, either plant, animal, or microorganism, in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating or natural recombination." Below is a diagram of how bacterial gene is introduced through genetic engineering to plant cells and tissues to develop and breed a genetically modified plant.

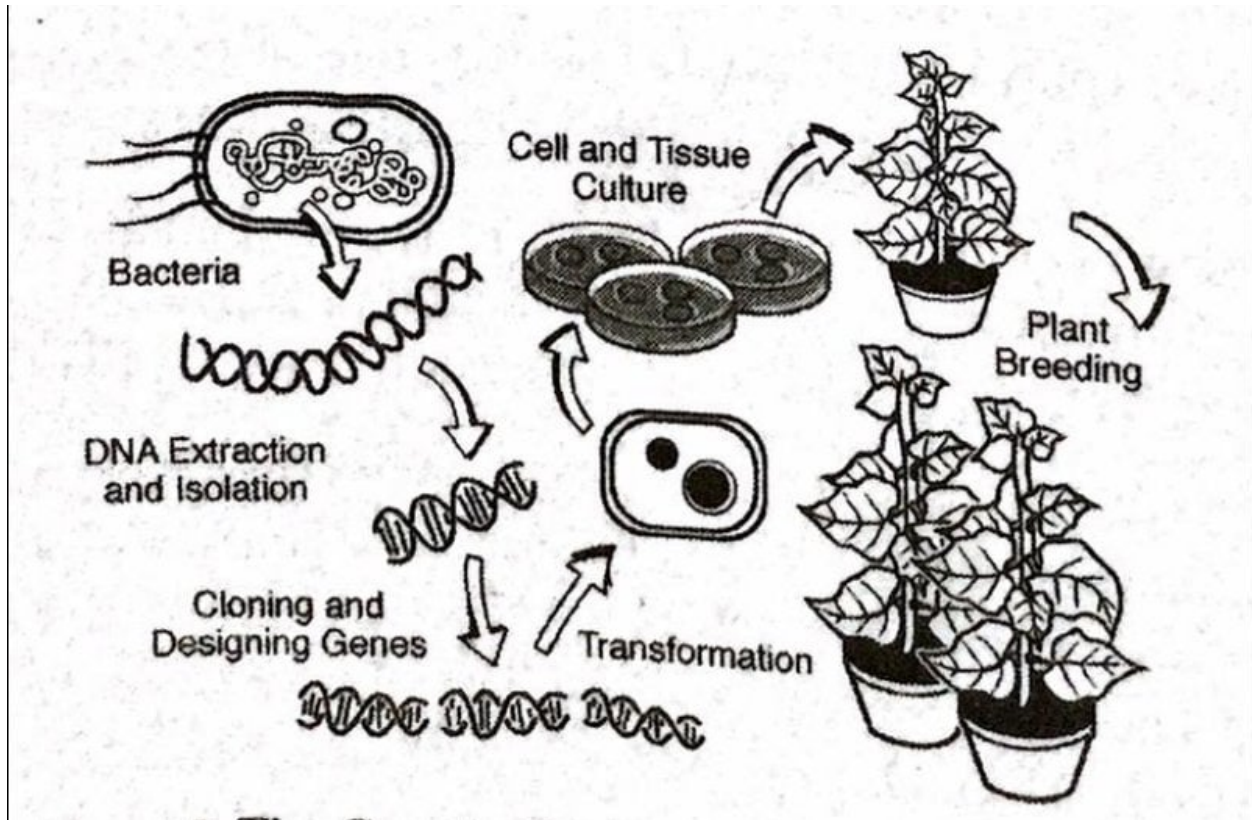


Figure 8. The Genetic Engineering Process on a Plant

The development of GMOs was perceived to industries in the advancement of technology for the benefit of humans in different industries like agriculture and medicine.

GMOs in Food and Agricultural Industries

The Center for Ecogenetics and Environmental Health (CEEH, 2013) identified the following roles of GMOs in the food and agricultural industries;

1. Pest resistance - genetically modified plants to resist certain pests.

An example is Bt Corn. The DNA (genome) of the Bt Corn has been modified with the gene of *Bacillus thuringiensis*, a soil bacterium that produces proteins which is toxic to corn borers (worms).



2. Virus resistance -genetically modified plants to resist certain viruses.

An example is GM papaya or rainbow papaya. The papaya ring spot virus (PRSV) is known to be detrimental to papaya plants. The protein of PRSV was introduced to the papaya plant through plant tissue which turned out to be resistant to the virus itself. The effect was like the vaccines humans have against measles or influenza virus.



3. Herbicide tolerance - genetically modified plants to tolerate herbicide.

An example is Roundup Ready soybean. Glyphosate, an herbicide for weeds, was introduced to soybeans making them tolerant to the herbicide itself. Farmers then can spray the herbicide killing the weeds but not the soybeans.

4. Fortification genetically modified plants fortified with certain minerals.

An example is Golden Rice. Beta-carotene, a precursor of Vitamin A, was introduced through biosynthesis genes to the rice, making the rice grains fortified with vitamin A.

5. Cosmetic preservation - genetically modified plants resist natural discoloration.

An example is Arctic Apple. The apple variety was genetically modified to suppress the browning of apple due to superficial damage.

6. Increase growth rate - a genetically modified organism that has a higher yield in growth than normal species.

An example is AquAdvantage salmon. A gene from an ocean pout, an eel-like fish was introduced to Pacific Chinook salmon, making the salmon grow faster than its normal rate.



GMOs in Non-Food Crops and Microorganisms

Genetically modified organisms (GMOs) in non-food crops and some microorganisms involve the following:

1. Flower production GMOS in flower production are seen in modified color and extended vase life of flowers.

Examples are Blue Roses, The so-called "blue" roses, which are, in reality, lilac or purple, contained cyanidin 3,5-diglucoside together with large amounts of flavonols. The introduction of the flavonoid 3,5-hydroxylase gene into pelargonidin- or cyaniding-producing rose cultivars diverts the anthocyanin biosynthetic pathway toward the production of delphinidin glucosides and the flower color to blue (Elomaa & Holton, 1994).

2. Production - modified characteristics of trees for higher yield of paper production.

Examples are poplar trees. Lignin is a complex polymer in trees that is removed from wood to make paper through the kraft process, through inserting genes that code for ferulic acid in young poplar trees, the lignin structure is modified, making lignin easier to breakdown (Veniza, 2014).

3. Pharmaceutical productions modified plants to produce pharmaceutical products.

Examples are periwinkle plants. Bacterial genes were added to the periwinkle plant to enhance the production of vinblastine, an alkaloid usually added to drugs for cancer treatments like Hodgkin's lymphoma (Rungtaphan, 2010).



4. Bioremediation use of modified plants that can assist in the bioremediation of polluted sites.

An example is shrub tobacco. *Nicotiana glauca*, or shrub tobacco genetically modified with phytochelatins TaPCS11, is used for bioremediation. It shows high level accumulation of zinc, lead, cadmium, nickel, and boron and produces high biomass.



figure 9: *Nicotiana glauca*

5. Enzyme and drug production- use of modified microorganisms that can produce enzymes for food processing and medicines.

One example of this is CGTase. Cyclomaltodextrin glycosyltransferase (cGTase), an enzyme used for food flavor enhancer, is produced in higher quantity by bacterium *Bacillus* which was genetically modified with the gene of a thermophilic anaerobe, *Thermoanaerobacter*, carrying cGTase (Pedersen & Jorgensen, 1995).

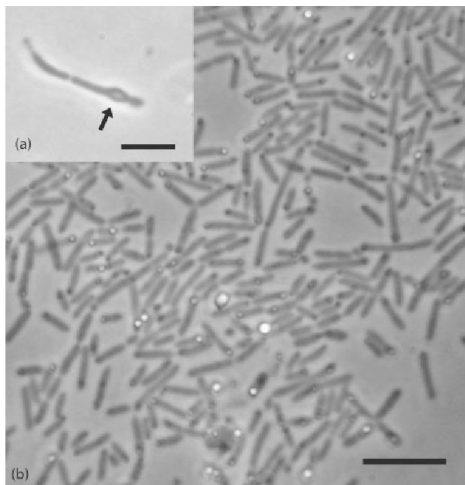


Figure 10. *Thermoanaerobacter*

Another example is artemisinin. Artemisinin acid is a compound used for anti-malarial drug extracted from sweet wormwood plant. Through genetic engineering, it can be synthetically produced by yeast and bacteria with sweet wormwood plant gene (Zimmer, 2006).

6. GMOs in the medical field-genetic engineering are playing a significant role from diagnosis to treatment of human-dreaded diseases. It helps in the production of drugs, gene therapy, and laboratory researches.

One classic example is Humulin, the genetically engineered insulin used by Type 1 diabetes patients who are insulin- dependent. In the past, insulin is extracted from the pancreases or pigs and cows that have caused allergic reactions diabetics using it. In 1978, researchers from the City of National Medical Center and Genentech Biotechnology Company were able to produce human insulin. The gene insulin was inserted to bacterial DNA that was able to produce almost exactly the same human insulin. This was a breakthrough in the mass production of human insulin. In 1996, modified human insulin was approved, called the *Humalog*.



Figure 11. Humulin, a sample of genetically engineered insulin.

Benefits of GMOs

Studies show some of the potential benefits of GMOs:

- Higher efficiency in farming- with the use of pesticide- resistant/herbicide-tolerant GMO crops, there will be less use for herbicides/pesticides, and lower cost for labor and cultivation.
- Increase in harvest GMO crops resistant to pests and diseases means increase in potential growth and harvest.
- Control in fertility controlling the purity of the hybrid seeds (GMO seeds) ensures higher yields.
- Increase in food processing altered characteristics of GM10 crops help ease food processing.
- Improvement of desirable characteristics -GMOs offer longer shelf life, enhanced color and taste, enhanced production or reduction of enzymes, and other modified characteristics of plants, animals, and microorganisms 139 in Science, Technology, and Society
- Nutritional and pharmaceutical enhancement GMO Crops like maize fortified with lysine and Golden Rice fortified with vitamin A and iron. There are now edible vaccines for viral and diarrheal diseases.
- Reduce the use of fertilizer and pesticides

There are over 400 million acres of GMO farmlands all over the world. The top five countries that operate GMO farmlands are the United States, Brazil, Argentina, India, and Canada. Some of the GMO agricultural crops that have been approved for public consumption and are already in the market include: alfalfa, corn, papaya, soya bean, sugar beets, and squash. Most of these GMO crops were made to be resistant to pests. Some examples of common food with GMOs are Kellogg's Cornflakes, Quaker Chewy Granola Bars, Ultra Slim Fast, Quaker Yellow Corn Meal, and Alpo Dry Pet Food.

In the animal industries, there are ongoing researches like studies on Pacific salmon that grows twice faster than the native salmon and chicken resistant to H5N1 bird flu viruses. However, these GMO animals are all in research laboratory and not yet approved for public consumption.

Potential Risks of GMOs

Despite the promising claims of GMOs, the opponents of GMOs claim otherwise. For example, there are studies that show a link in the adaption of pesticide-resistant GMO crops to the significant growth of super weeds that became pesticide-resistant, too. This caused additional problem to more than 12 million acres of farms in the United States.

Opponents of GMOs have the following major concerns:

1. Since genetic engineering IS still a young branch of science, there are inadequate studies on the effects of GMOs to humans and the environment.
2. Genetic engineering promotes mutation in organisms which the long term effect is still unknown.
3. Human consumption of GMOs might have the following effects:
 - More allergic reactions GMO food may trigger o allergic reactions, more so create new ones, as side erect O the gene alteration.
 - Gene mutation - GMO food may develop abnormalities and mutation, more than the desired product of the gene alteration.
 - Antibiotic resistance- GMO food contains antibiotic- resistant genes; this may cause disease-causing bacteria likely to be more antibiotic-resistant too, increasing the possibility of widespread of the disease.
 - Nutritional value GMO food may have change in their nutritional value.

Potential Environmental Risks Caused By GMOs

Karki (2006) summarized the perceived potential environmental risks caused by GMOs. The identified major risks are the following:

1. Risk in gene flow - there is a potential risk of the modified gene to be transferred from the GMO crop to its wild relative or organism in the soil and human intestine (when ingested). For example, a decaying GMO plant could possibly transfer the modified genes to the bacteria and fungi in the soil. Bacteria and fungi are capable of using a genetic material from their

surroundings. There are no studies yet on the effects of the absorbed modified gene to the other organisms.

2. Emergence of new forms of resistance and secondary pests and weed problems- GMO crops resistant to certain pesticides may trigger new form of pest resistance while GMO herbicide- tolerant crops may lead to the over use of the herbicides which Emergence of new forms of resistance and secondary pests and may trigger new form of weed resistance.
3. Recombination of Virus and Bacteria to Produce New Pathogens - the modified gene can be transferred and integrated in the viral or bacterial genes which may lead too viral or bacterial gene modification or mutation. This living modified virus and bacteria may then cause new disease that may affect other organisms including human beings.

Other direct and indirect environmental risks caused by MOs (Molfino & Zucco, 2008):

1. Direct environmental risks are
 - introduction of the GMOs in the natural environment may cause disruption of the natural communities through competition or interference;
 - the possibility of unexpected behavior of the GMOs in the environment if it escapes its intended use and may post threats or become pest;
 - may cause harmful effects to ecosystem processes if GMOs interfere with the natural biochemical cycles; and
 - the persistence of GMO genes after its harvest which may cause negative impacts to the consumer of GMO products.
2. Indirect environmental risks are
 - alteration of agricultural practices like managing negative impacts of GMOs to the environment such as evolution of insects, pests, and weeds that became resistant to GMO crops;
 - May have impacts to biodiversity caused by the alteration in agricultural practices; and
 - may have varied environmental impacts due to GMOs interaction and release in the natural environment.

Potential Human Health Risks caused by GMOs

A major concern in the use and consumption of GMOs is its effect on human beings, primarily on human health. Some potential human health risks are identified (Akhter, 2001), such as:

- Consumption of GMOs may have adverse effects since it is n naturally or organically produced;
- Consumption of GMOs may alter the balance of existing microorganisms in the human digestive system;

- production of toxins may be detrimental to human health; and
- Production of allergens may have adverse effects on humans.

Worldwide, there are many groups that campaign against GMO food consumption. They encourage people to boycott GMO products and to be vigilant in checking if the food they buy has GMO ingredients. In the Philippines, the Supreme Court has ruled against the use of Bt eggplant, another genetically modified crop (Ongkiko, 2016).

Other potential risks that raise major concern are:

- Human Genome Project (HGP)- Mapping of human genes to provide framework for research and studies in the field of medicine. It was feared that the ability to produce human genetic information would create biases and give much power to people holding the information and to the disadvantage of those who do not have the genetic information.
- Mutation of genetically engineered microorganisms - Genetically modified bacteria and viruses may mutate to become more resistant or virulent that may cause more dreadful diseases for human beings.
- Cloning- The asexual reproduction of an organism using parent cell through genetic engineering. In February 24, 1997, the first mammal, Dolly, a sheep from Scotland, was born through cloning. With its celebrated success came the fear of human cloning. It emerged the ethical issue of man "playing God."

Scientists and medical practitioners would definitely continue to search for ways to preserve lives. Genetic engineering is perceived to be one of the keys to this venture. Gene therapy and gene alteration are promising ways to improve human health conditions.

On the other hand, great fears loom in the process of this quest. There are many things to be considered before a certain medical process using genetic engineering is accepted.

These concerns were affirmed by the reports, of the World Health Organization. WHO reported three major issues on GMOs that are in international public debates. These are the potential risks of allergic reactions, gene transfer/flow, and outcrossing (WHO, 2014).

The primary issue on GMOs presented in public debate is its unnatural production or what is termed to be a violation of nature. The creation of new organisms, like GMOs, poses moral issues on defiance to natural laws. Another concern is the potential risks to the environment and human health, to which so much is unknown yet.

Biosafety on GMOs

There are initiatives for the protection of the general human population regarding the issues and concerns about GMOs. International organizations developed principles and treaties that somehow ensure biosafety on GMOs. Some of these initiatives are as follows:

- *The Codex Alimentarius Commission* (Codex). The Food and Agricultural Organization (FAO) together with the World Health Organization (WHO) created The Codex Alimentarius Commission (Codex). Codex is an intergovernmental body that develops the Codex Alimentarius, known as the International Food Code. Codex is responsible for the development of standards, codes of practices, guidelines, and recommendations on food safety. With the pressing issues and concerns on GMOs, in 2003, Codex has developed principles for the human health risk analysis of genetically modified (GM) food products. The principles include pre-market assessments of GM food products and its evaluation of direct and indirect effects. However, the Codex principles has no binding effect on national legislation but through the sanitary and phytosanitary measures of the World Trade Organization, national legislators are encouraged to complement their national standards with the Codex Principles (WHO, 2014).
- *Cartagena Protocol on Biosafety*. Established in 2003, Cartagena Protocol is an international environmental treaty that regulates the trans boundary movements of Living Modified Organisms (LMOs). The Cartagena Protocol requires exporters to seek consent from the importers before its first shipment of LMOs (WHO, 2014).
- *International Trade Agreement on labeling of GM food and food products*. The agreement requires exporters of GM and food products to label their products and give rights to 'importing parties to reject or accept the GM products. The premise of this policy is that consumers have the right to know and the freedom to choose GM or non-GM products (Whitman, 2000).

The World Health Organization (WHO, 2014) claims that all GM products that are available in the international market have passed safety assessment by national authorities. The safety assessments basically look at the environmental and health risk factors and food safety usually follows the Codex Food Code.

GMOs in Philippine Context

Introduction of GMOs in our country created issues and controversies similar to other countries with GMOs. There are, of course, proponents and opponents of these issues.

The GMO concern started in the 1990s with the creation of the National Committee on Biosafety of the Philippines (NCBP) through Executive Order No. 430 of 1990. The NCBP developed the guidelines on the planned release of genetically manipulated organisms (GMOs) and potentially harmful exotic species in 1998. In 2002, the Department of Agriculture released Administrative Order No. 8, the guideline for the importation and release into the environment of GM plants and plant products. On that same year, the entry of GMO importation started (Baumuller, 2003). The Philippines was marked to be the first country in Asia to approved commercial cultivation of GMOs when GM corn planting was approved in 2002 (Serapio & Dela Cruz, 2016).

From December 2002 to present, there are 70 GMO applications approved by the Department of Agriculture for the release to the environment, 62 GMOs of which are approved for food feed and processing and the remaining 8 were approved for propagation (Aruelo, 2016).

In 2004, the Philippines was classified by International Service for acquisition of agri-biotech applications as one of the fourteen biotech- mega countries which grow 50,000 hectares or more of GMO crops annually (James, 2004). In that same year, Senator Juan Flavio Velasco authored a bill on the mandatory labeling of food and food products with GMOs. The Senate did not pass the bill.

In 2006, the Philippines became part of the Cartagena Protocol on Biosafety. In the same year, Executive Order No. 514 was issued to address the biosafety requirements of the Cartagena Protocol and the establishment of the National Biosafety Framework (NBF).

In 2010, the Organic Agriculture Act was issued, encouraging organic agriculture than GMO-related agriculture. Prior to this act, there are several provinces like Negros Occidental and Negros Oriental which agreed to support organic agriculture. There was the establishment of the Negros Organic Island through a memorandum of agreement (MOA) between the two provinces in 2005. With this MOA, the two provinces were able to ban the entry of GMOs and living GMOs to their provinces through provincial ordinance. Similar to this case, Davao City passed the Organic Agriculture Ordinance in 2010. This city ordinance helps the prevention of field testing of GM Bt eggplant in the UP Mindanao Campus (Aruelo, 2016).

In 2012, Representative Teddy Casiño, together with other congressmen, filed a bill pushing for the mandatory labeling of GM food and food products. To date, there is no Philippine biosafety law, only biosafety regulations formed under NBF.

A study on the biosafety regulations of the Philippines concluded that the existing regulation is weak, which can be fixed through legislation such as a republic act (Richmond, 2006).

In December 2015, the Supreme Court ordered to put an end to the field testing of GMO Bt eggplant and declared Administrative Order No. 8, series of 2002 of the Department of Agriculture as null and void. This means that any actions or procedures related to GMO importations and propagation is temporarily put to stop until a new administrative order is issued in accordance with the law.

In March 7, 2016, five government agencies namely, the Department of Science and Technology, Department of Agriculture, Department of Environment and Natural Resources, Department of Health, and Department of the Interior and Local Government, passed a Joint Department Circular No. 1, series of 2016 on rules and regulations for the research and development, handling and use, transboundary movement release in the environment, and management of the genetically modified plant and plant products derived from the use of modern biotechnology. This Joint department circular paves way to issuance of new permits for planting and importing GM crops in the country.

SUMMARY

Genetic engineering is an emerging field of science. Its quests are to preserve and prolong life. In more than four decades since the first genetically modified bacteria was produced, thousands of genetically modified organisms have been created and propagated. Some are approved by experts and

government authorities for human use and consumption while others are kept in institutional research laboratories subject for more experiments.

There are advantages and disadvantages in using genetic engineering in both fields of medicine and food and agriculture, there are controversies that are still debatable up to the present. The major concern of the opponents is the long-term effect of GMOs to humans while the proponents' flagship is the success stories of the GMO recipients.

There is still a long way to go for GMOs to prove itself, as humans seek answers to life's predicaments or as humans play like God.

LESSON 4

THE NANO WORLD

LESSON OBJECTIVES

At the end of this lesson, the students should be able to:

- define nanotechnology;
- characterize nanoscale;
- describe the various uses of nanotechnology;
- discuss concerns on the use of nanotechnology; and
- Explain the status of the use of nanotechnology in the Philippines.

INTRODUCTION

Scientific researchers have developed new technological tools that greatly improve different aspects of our lives. The use of nanoscale is one important interdisciplinary area generated by advancement in science and technology. Scientists and engineers were able to build materials with innovative properties as they manipulate nanomaterials. Indeed, research and application of knowledge on nanomaterials will continue to bring widespread implications in various areas of the society, especially health care, environment, energy, food, water, and agriculture.

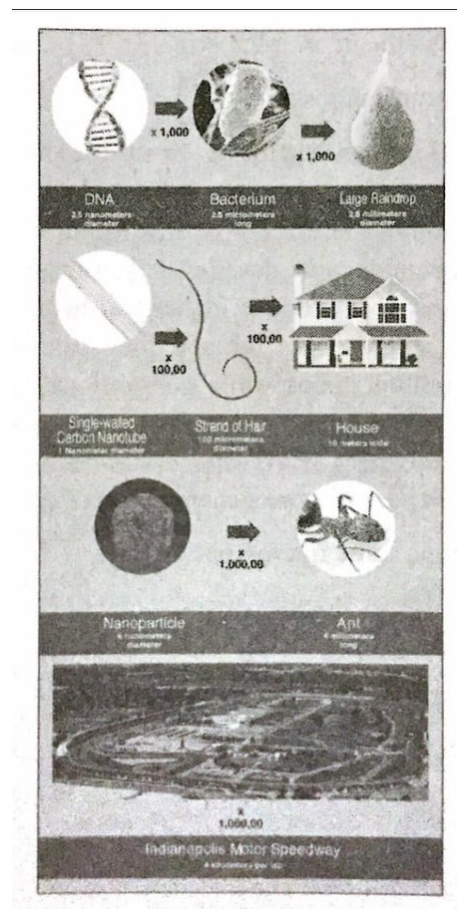
Nanotechnology refers to the science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers (NNI, 2017). Nanoscience and nanotechnology employs the study and application of exceptionally small things in other areas of science including materials science, engineering, physics, biology, and chemistry (NNI, 2017)

The concepts of nanotechnology and nanoscience started December 29, 1959 when Physicist Richard Feynman discussed a method in which scientists can direct and control individual atoms and molecules in his talk "There's Plenty of Room at the Bottom" during the American Physical Society meeting at the California Institute of Technology. The term "nanotechnology"

was coined by Professor Norio Taniguchi a decade after the dawn of the use of ultra-precision machining (NNI, 2017)

How Small is a Nanoscale?

A nanometer is a billionth of a meter, or 10^9 of a meter. The illustration below shows how small nanoscale is compared to other particles or materials.



Manipulation of nanomaterials needs an adept understanding of their types and dimensions. The various types of nanomaterials are classified according to their individual shapes and sizes. They may be particles, tubes, wires, films, flakes, or shells that have one or more nanometer-Sized dimensions. One should be able to view and manipulate them so that we can take advantage of their exceptional characteristics.

How to View Nanomaterials

Scientists use special types of microscopes to view minute nanomaterials. During the early 1930s, scientists used electron microscopes and field microscopes to look at the

nanoscale. The scanning tunneling microscope and atomic force microscope are just among the modern and remarkable advancements in microscopy.

1. Electron microscope

German engineers Ernst Ruska and Max Knoll built the first electron microscope during the 1930s. This type of microscope utilizes a particle beam of electrons to light up a specimen and develop a well-magnified image. Electron microscopes produce higher and better resolution than older light microscopes because they can magnify objects up to a million times while conventional light microscopes can magnify objects up to 1,500 times only. Scanning electron microscope (SEM) and transmission electron microscope (TEM) are the two general types of electron microscope.

2. Atomic force microscope (AFM)

It was first developed by Gerd Binnig, Calvin Quate, and Christoph Gerber in 1986. It makes use of a mechanical probe that gathers information from the surface of a material.



3. Scanning tunneling microscope

This special type of microscope enables scientists view and manipulates nanoscale particles, atoms, and small molecules. In 1986, Gerd Binnig and Heinrich Rohrer won the Nobel Prize in Physics because of this invention.

Nanomanufacturing

It refers to scaled-up, reliable, and cost-effective manufacturing of nanoscale materials, structures, devices, and systems. It also involves research, improvement, and incorporation of processes for the construction of materials. Therefore, nanomanufacturing leads to the development of new products and improved materials. There are two fundamental approaches to nanomanufacturing, either bottom-up or top-down (NNI, 2017):

1. Bottom-up fabrication

It manufactures products by building them up from atomic- and molecular-scale components. However, this method can be time-consuming. Scientists and engineers are still in search for effective ways of putting up together molecular components that self-assemble and from the bottom-up to organized structures.

2. Top-down fabrication

It trims down large pieces of materials into nanoscale. This process needs larger amounts of materials and discards excess raw materials.

There are new approaches to the assembly of nanomaterials based from the application of principles in top-down and bottom-up fabrication. These include:

- Dip pen lithography

It is a method in which the tip of an atomic force microscope is "dipped" into a chemical fluid and then utilized to "write" on a surface, like an old-fashioned ink pen onto

- Self-assembly

it depicts an approach wherein a set of components join together to mold an organized structure in the absence of an outside direction.

- Chemical vapor deposition

It is a procedure wherein chemicals act in response to form very pure, high-performance films.

- Nanoimprint lithography

It is a method of generating nanoscale attributes by stamping or "printing" them onto a surface.

- Molecular beam epitaxy

It is one manner for depositing extremely controlled thin films.

- Roll-to-roll processing

It is a high-volume practice for constructing nanoscale devices on a roll of ultrathin plastic or metal.

- Atomic layer epitaxy

It is a means for laying down one-atom-thick layers on a surface.

With the use of these techniques, nanomaterials are made more durable, stronger, lighter, water-repellent, ultraviolet- or infrared- resistant, scratch-resistant, electrically conductive, antireflective, antifog, antimicrobial, self-cleaning, among others. The abovementioned characteristics lead to the manufacture of the present variety of nanotechnology-enabled

products such as tennis rackets and baseball bats to catalysts for purifying crude oil and ultrasensitive recognition and classification of biological and chemical toxins.

It is not impossible that in the near future, computers that are better, more efficient, with larger storage of memory, faster, and energy- saving will be developed. Soon, the entire memory of a computer will be saved in a single tiny chip. Moreover, nanotechnology has the potential to construct high-efficiency, low-cost batteries and solar cells.

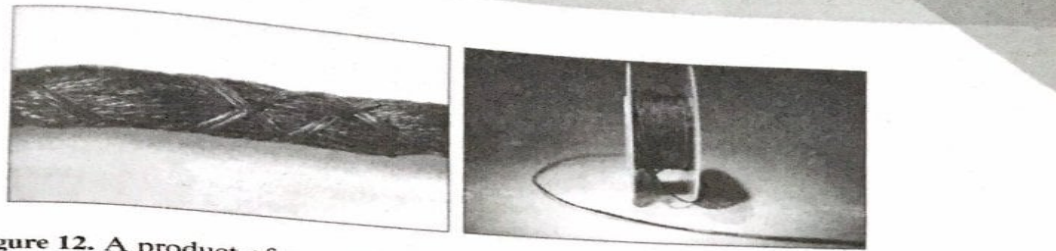


Figure 12. A product of nanomanufacturing: A 16 gauge wire, approximately 1.3 millimeters in diameter, made from carbon nanotubes that were spun into thread and the same wire on a 150 ply spool. (Source: Nanocomp).

Distinct Features of Nanoscale

Nanotechnology involves operating at a very small dimension and it allows scientists to make use of the exceptional optical, chemical, physical, mechanical, and biological qualities of materials of that small scale (NNI, 2017). The following are distinct features of nanoscale:

1. Scale at which much biology occurs.

Various activities of the cells take place at the nanoscale. The deoxyribonucleic acid (DNA) serves as the genetic material of the cell and is only about 2 nanometers in diameter.

Furthermore, the hemoglobin that transports oxygen to the tissues throughout the body is 5.5 nanometers in diameter.

A good number of modern researches focus on advancing procedures, therapies, tools, and treatments that are more accurate and custom-made than traditional methods and cause no adverse effects on the body.

An example of this is the bio-barcode assay, which is a fairly inexpensive approach for identification of specific disease markers in the blood despite their small number in a particular specimen.

2. Scale at which quantum effects dominate properties of materials.

Particles with dimensions of 1-100 nanometers have properties that are significantly discrete from particles of bigger dimensions. Quantum effects direct the behavior and properties of particles in this size scale. The properties

Of materials are highly dependent on their size. Among the essential properties of nanoscale that change as a function of size include chemical reactivity, fluorescence, magnetic permeability, melting point, and electrical conductivity.

One example is the nanoscale gold, which is, not only the yellow-colored element we are used to seeing but it can also appear red or purple. Gold's electrons display restricted motion in the nanoscale. Practically, nanoscale gold particles selectively build up in tumors, where they permit both precise imaging and targeted laser destruction of the tumor while avoiding damage on healthy cells.

3. Nanoscale materials have far larger surface areas than similar masses of larger-scale materials.

As we increase the surface area per mass of a particular material, a greater amount of the material comes in contact with another material and can affect its reactivity.

If a cubic centimeter is filled with micrometer-sized cubes—a trillion (10^{12}) of them, each with a surface area of 6 square micrometers—the total surface area amounts to 6 square meters, or about the area of the main bathroom in an average house. When that single cubic centimeter of volume is filled with 1-nanometer-sized cubes— 10^{21} of them, each with an area of 6 square nanometers—their total surface area comes to 6,000 square meters.

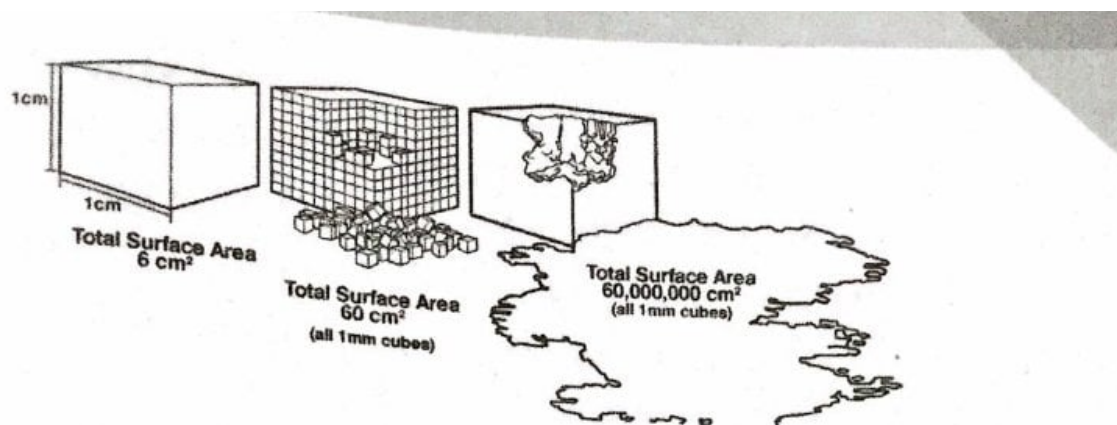


Figure 13. The Effect of the Increased Surface Area Provided by Nanostructured Materials

Government Funding for Nanotechnology in Different Countries (Dayrit, 2005)

1. U.S. National Nanotechnology Initiative
 - The best-known and most-funded program is the National Nanotechnology Initiative of the United States. The NNI was established in 2001 to coordinate U.S. federal

nanotechnology R&D. The NNI budget in 2008 and 2009 were \$1.4 billion and \$1.5 billion, respectively.

2. European Commission
 - In February 2008, the EC officially launched the European Nanoelectronics Initiative Advisory Council (ENIAC).
3. Japan (Nanotechnology Research Institute, under the National Institute for Advanced Industrial Science and Technology, AIST)
4. Taiwan (Taiwan National Science and Technology Program 4. for Nanoscience and Nanotechnology))
5. India (Nanotechnology Research and Education Foundation)
6. China (National Center for Nanoscience and Technology)
7. Israel (Israel National Nanotechnology Initiative)
8. Australia (Australian Office of Nanotechnology)
9. Canada (National Institute for Nanotechnology or NINT)
10. South Korea (Korea National Nanotechnology Initiative)
11. Thailand (National Nanotechnology Center or NANOTEC)
12. Malaysia (National [Malaysia] Nanotechnology Initiatives or NNI)

Possible Applications of Nanotechnology in the Philippines (Dayrit, 2005)

1. ICT and semiconductors
2. Health and medicine
3. Energy
4. Food and agriculture
5. Environment

Nanotech Roadmap for the Philippines (funded by PCAS-TRD-DOST)

1. ICT and semiconductors
2. Health and biomedical
3. Energy
4. Environment
5. Agriculture and food
6. Health and environmental risk
7. Nano-metrology
8. Education and public awareness

Benefits and Concerns of Using

Nanotechnology

Nanotechnology has various applications in different sectors or the society and environment. Salamanca-Buentello et al. (2005) proposed an initiative called "Addressing Global Challenges Using Nanotechnology to accelerate the use of nanotechnology to address critical sustainable development challenges. They suggested a model that could help figure out the possible contributions of the community in overcoming global challenges that pose risk on health and other aspects of peoples' lives. However, there are concerns that need to be addressed before using and promoting materials derived from nanotechnology (Dayrit, 2005).

1. Nanotechnology is not a single technology; it may become pervasive.
2. Nanotechnology seeks to develop new materials with specific properties.
3. Nanotechnology may introduce new efficiencies and paradigms which may make some natural resources and current practices uncompetitive or obsolete.
4. It may be complicated to detect its presence unless one has the specialist tools of nanotechnology.

Table 2. Benefits and Concerns of the Application of Nanotechnology in Different Areas

Example of Areas Affected by Nanotechnology	Possible Benefits	Concerns
Environment	• Improved detection and removal of contaminants • Development or benign industrial processes and materials	• High reactivity and toxicity • Pervasive distribution in contaminants the environment • No nano-specific EPA regulation
Health	Improved medicine	• Ability to cross cell membranes and translocate in the body • No FDA approval needed for cosmetics or supplements
Economy	• Better products	• Redistribution of

	• New jobs	wealth • Potential cost of cleanups and health care • Accessibility to all income levels
--	--	---

Social and Ethical Considerations in Conducting Research on Nanotechnology

1. Who will benefit from it? On the other hand, who won't?
2. For whom and what are your objectives for developing your product?
3. How will it affect social, economic, and political relationships?
4. What problem is your "product" trying to solve?
5. Who will have access to it? Who will be excluded?
6. Are there dangers involved with its development (e.g., safety, health, pollution)? How can you minimize them?
7. Who will own it? How can you assure access to it?

SUMMARY

Nanotechnology is an advanced interdisciplinary field that encompasses science and technology that manufactures materials of great help to the improvement of various areas of society especially health care, environment, energy, food, water, and agriculture. It is a field that that in needs to be explored, not only by known experts but also neopnytcS, a order to advance our knowledge of science and technology, and mol importantly, to help improve our quality of life. But, before we engage in nanotechnology, we need to take into account the social, ethical, an environmental concern of using such nanomaterials. .

LESSON 5

THE ASPECTS OF GENE THERAPY

LESSON OBJECTIVES

At the end of this lesson, the students should be able to: describe gene therapy and its various forms; and assess the issue's potential benefits and detriments to global1 health.

INTRODUCTION

Medical science has detected many human diseases related to defective genes. These types of diseases are not curable by traditional methods like taking readily available medicines. Gene therapy is a potential method to either treat or cure genetic-related human illnesses.

In 2015, a team of researchers at the Harvard Medical School and the Boston Children's Hospital stated that they were able to restore basic hearing in genetically deaf mice using gene therapy. The Boston Children's Hospital research team also reported that they have restored a higher level of hearing-down to 25 decibels which is actually equivalent to a whisper. They used an improved gene therapy vector developed at the Massachusetts Eye and Ear that was identified as "Anc80" which enables the transfer of genes to the inaccessible outer hair cells when introduced into the cochlea (Fliesler, 2017).

Human gene therapy was actually first realized in 1971 when the first recombinant DNA experiments were planned. It can be simply viewed as insertion foreign DNA into a patient's tissue that hope to successfully eradicate the targeted disease. It was actually inspired by the Success of recombinant DNA technology which occurred over the last 20 years. Without a doubt, gene therapy is the most promising yet possibly unfavorable medical field being studied.

The Basic Process

There are several approaches to gene therapy. These are the following (Fliesler, 2017):

- Replacement of mutated gene that causes disease with a healthy copy of the gene
- Inactivation of a mutated gene that is functioning improperly
- Introducing a new gene into the body to help fight a disease

In general, a gene cannot be directly inserted into a human gene or cell. A gene is inserted into another gene using a carrier or vector. At present, the most common type of vectors is viruses that have been genetically changed to carry normal human DNA. Viruses have evolved a way of encapsulating and transporting their genes to human cells in a pathogenic manner (Science Daily, 2017).

Two Types of Gene Therapy

The idea of gene therapy is based on correcting a disease at its root; fixing the abnormal genes that appear to lead to certain diseases.

There are essentially two forms of gene therapy. One of which is called somatic gene therapy. Somatic gene therapy involves the manipulation of genes in cells that will be helpful to the patient but not inherited to the next generation (Nimsergern, 1988).

The other form of gene therapy is called germ-line gene therapy which involves the genetic modification of germ cells or the origin cells that will pass the change on to the next generation (Your Genome, 2017).

Stem Cell Gene Therapy

Stem cells are mother cells that have the potential to become any type of cell in the body. One of the main characteristics of stem cells is their ability to self-renew or multiply while maintaining the potential to develop into other types of cells. Stem cells can become cells of the blood, heart, bones, skin, muscles, and brain, among others. There are different sources of stem cells but all types of stem cells have the same capacity to develop into multiple types of cells.

Stem cells are derived from different sources. Two of which are embryonic and somatic stem cells.

The embryonic stem cells are derived from a four- or five-day-old human embryo that is in the blastocyst phase of development. The embryos are usually extras that have been created in IVF (in vitro fertilization) clinics where several eggs are fertilized in a test tube then implanted into a woman (Crosta, 2013).

The somatic stem cells are cells that exist throughout the body after embryonic development and are found inside of different types of tissue. These stem cells have been found in tissues such as the brain, bone marrow, blood, blood vessels, skeletal muscles, skin, and the liver. They remain in a non-dividing state for years until activated by disease or tissue injury. These stem cells can divide or self-renew indefinitely, enabling them to generate a range of cell types from the originating organ or even regenerate the entire original organ. It is generally thought that adult or somatic stem cells are limited in their ability to differentiate based on their tissue of origin, but there is some evidence to suggest that they can differentiate to become other cell types (Crosta, 2013).

The Bioethics of Gene Therapy

There are ethical issues involved in gene therapy. Some of the inquiries cited are (Genetics Home Reference, 2017):

1. How can "good" and "bad" uses of gene therapy be distinguished?
2. Who decides which traits are normal and which constitute a disability or disorder?
3. Will the high costs of gene therapy make it available only to the wealthy?
4. Could the widespread use of gene therapy make society less accepting of people who are different?
5. Should people be allowed to use gene therapy to enhance basic human traits such as height, intelligence, or athletic ability?

Another controversy involves the germline therapy. As discussed, germline therapy is genetic modification of germ cells that will pass the change on to the next generation. There are a lot of questions on the effects of the gene alteration to the unborn child and the next generation, since the alteration can be passed on. In the United States, the government does not fund researches on human germline gene therapy.

SUMMARY

Gene therapy is a method that may treat or cure genetic-related human illnesses. There are two forms of gene therapy. One is somatic gene therapy which involves the manipulation of genes in cells that will be helpful to the patient but not inherited to the next generation. The other is germline gene therapy which involves the genetic modification of germ cells or the origin cells that will pass the change to the next generation.

There are many ethical issues on gene therapy. Some of these issues are about questions on whose authority or power to decide which human traits should be altered; other concerns are on the discriminatory effects of those who may not or cannot avail gene therapy.

LESSON 6

CLIMATE CHANGE -LESSON OBJECTIVES

At the end of this lesson, the students should be able to: identify the causes of climate change; understand the effects of climate change on the society; and illustrate how the community helps in mitigating the hazards caused by climate change.

INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC), a United Nations body that evaluates climate change science, released its report on global climate change. The report's important conclusions were the following: world's climate has changed significantly over the past century; the significant change has human influence; using climate models and if the trend continues, the global mean surface temperature will increase between 1°C and 3.5°C by 2100.

Why should a few degrees of warming be a cause for a concern? According to experts, global climate change could have a greater potential to change life in our planet than anything else except a nuclear war. These changes will also lead to a number of potentially serious consequences.

But first, what is climate change? Climate change refers to the statistically significant changes in climate for continuous period of time. Factors that contribute to climate change can be natural internal process, external forces, and persistent anthropogenic changes in the composition of the atmosphere or in land use. It can also be due to natural occurrences or contributed by acts of human beings.

This lesson will present the causes of climate change and its effects on the society.

Causes of Climate Change

The causes of climate change could be natural or by human activities.

Natural Causes

Volcanic Eruptions

Volcanic eruptions are one of the natural causes of climate change. When volcanoes erupt, it emits different natural aerosols like carbon dioxide, sulfur dioxides, salt crystals, volcanic ashes or dust, and even microorganisms like bacteria and viruses. The volcanic eruption can cause a cooling effect to the

lithosphere because its emitted aerosol can block a certain percentage of solar radiation. This cooling effect can last for one to two years.

What happens in violent volcanic eruptions is the release of ash particles in the stratosphere. The volcanic ashes which have sulfur dioxide combine with water vapor. It then forms to sulfuric acid and sulfurous aerosols. The sulfurous aerosols then are transported by easterly or westerly winds. Volcanoes located near the equator are more likely to cause global cooling because of the wind pattern. Volcanoes located near to north or south poles are less likely to cause cooling because of pole wind pattern, the sulfurous aerosols are confined in pole area.

There are several recorded major volcanic eruptions that cause climate change. Mount Tambora of Indonesia erupted in 1816. It was considered as the largest known eruption in human history. The eruption caused snowfall in the northeastern United States and Canada. It affected their agricultural lands, losing crops that caused food shortage and increased human mortality. The eruptions of Mount Krakatau of Indonesia in 1883 and Mount Pinatubo of the Philippines in 1991 contributed, too, to the cold years of planet Earth.

Orbital Changes

Earth's orbit can also cause climate change. This was proposed by the Milankovitch theory. The Milankovitch theory states "that as the Earth travels through space around the Sun, cyclical variations in three elements of Earth-Sun geometry combine to produce variations in the amount of solar energy that reaches Earth (Academic Emporia, 2017).

The three elements that have cyclic variations are eccentricity, obliquity, and precession.

Eccentricity is a term used to describe the shape of Earth's orbit around the Sun. The impact of the variation is a change in the amount of solar energy from perihelion (around January 3) to aphelion (around July 4). The time frame for the cycle is approximately 98,000 years (Academic Emporia, 2017). Currently Earth's eccentricity is 0.016 and there is about a 6.4% increase in insolation from July to January (Academic Emporia, 2017). Academic Emporia (2017) states, "The eccentricity influences seasonal differences: when Earth is closest to the Sun, it gets more solar radiation. If the perihelion occurs during the winter, the winter is less severe. If a hemisphere has its summer while closest to the Sun, summers are relatively warm."

Obliquity is the variation of the tilt of Earth's axis away from the orbital plane. As this tilt changes, the seasons become more exaggerated. The obliquity changes on a cycle taking approximately 40,000 years. Academic Emporia (2017) states "the more tilt means more severe seasons-warmer summers and colder winters; less tilt means less severe seasons-cooler summers and milder winters." Precession is the change in orientation of Earth's rotational axis.

The precession cycle takes about 19,000 to 23,000 years. Precession is caused by two factors: a wobble of Earth's axis and a turning around of the elliptical orbit of Earth itself (Academic Emporia, 2017). Obliquity affected the tilt of Earth's axis, precession affects the direction of Earth's axis. The change in

the axis location changes the dates of perihelion (closest distance from Sun) and aphelion (farthest distance from Sun), and this increases the seasonal contrast in one hemisphere while decreasing it in the other hemisphere (Academic Emporia, 2017). Currently, Earth is closest to the Sun in the Northern Hemisphere winter, which makes the winters there less severe (Academic Emporia, 2017). Another consequence of North Star was 1nuban in the constellation Draco. Currently, the North Star is Polaris in the constellation Ursa Minor. Precession is a shift in the celestial poles. Five thousand years ago, the

During the 1940s and 1950s, the theory fell into disrepute due to radiocarbon dating, indicating a lag in cooling versus insolation and to a scale problem with high frequency glacial advances (Academic Emporia, 2017). The theory was revived several times throughout the late 1960s to the present (Academic Emporia, 2017).

The Carbon Dioxide Theory

Carbon dioxide (CO₂) is added when power and heat are produced by burning coal, oil, and other fossil fuels. Carbon dioxide is transparent to sunshine but not invisible to infrared (heat) radiation leaving the ground. Carbon dioxide absorbs part of the infrared radiation in the air and returns it to the ground keeping the air near the surface warmer than it would be if the carbon dioxide did not act like a blanket. Doubling the carbon dioxide raises the temperature to 2°C to 3°C.

Human Activities

Human activities contribute to climate change. The largest known contribution comes from the burning of fossil fuels, which releases carbon dioxide gas to the atmosphere. Greenhouse gases and aerosols affect climate by altering incoming solar radiation and outgoing infrared (thermal) radiation that are part of Earth's energy balance. Changing the atmospheric abundance or properties of these gases and particles can lead to a warming or cooling of the climate system. Since the start of the industrial era (about 1750), the overall effect of human activities on climate has been a warming influence. The human impact on climate during this era greatly exceeds that due to known changes in natural processes, Such as solar changes and volcanic eruptions. Human activities result in emissions of four principal greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and the halocarbons (a group of gases containing fluorine, chlorine, and bromine). These gases accumulate in the atmosphere, causing concentrations to increase with time ([www. co2now.org](http://www.co2now.org))

The greenhouse gases mentioned are natural gases. However, the high level of these gases in the atmosphere contributes to the greenhouse effect. The increasing amount of these gases is due to human activities. High level of carbon dioxide comes from fossil fuel use in transportation; and the building, heating, cooling, and manufacture of cement and other goods. Deforestation releases carbon dioxide and reduces its uptake by plants. High methane emission is related to agriculture, natural gas distribution, and landfills. High nitrous oxide is also emitted by human activities such as fertilizer use and fossil fuel burning. Halocarbon gas concentrations have increased primarily due to human activities. Principal halocarbons include the chlorofluorocarbons (e.g., CFC-11 and CFC-12) which were used extensively as refrigeration agents and in other industrial processes before their presence in the atmosphere were found to cause stratospheric ozone depletion. The abundance of chlorofluorocarbon

gases is decreasing as a result of international regulations designed to protect the ozone layer (The Encyclopedia of Earth, 2016).

Ozone is another greenhouse gas that is continually produced and destroyed in the atmosphere by chemical reactions. In the troposphere, human activities have increased ozone through the release of gases such as carbon monoxide, hydrocarbons and nitrogen oxide, which chemically react to produce ozone.

Halocarbons released by human activities destroy ozone in the stratosphere and have caused the ozone hole over Antarctica. While water vapor is the most abundant and important greenhouse gas in the atmosphere, human activities have only a small direct influence on the amount of atmospheric water vapor. Indirectly, humans have the potential to affect water vapor substantially by changing climate. For example, a warmer atmosphere contains more water vapor. Human activities also influence water vapor through CH₄ emissions, because CH₄ undergoes chemical destruction in the stratosphere, producing a small amount of water vapor, and aerosols, the small particles present in the atmosphere with widely varying size, concentration, and chemical composition. Some aerosols are emitted directly into the atmosphere while others are formed from emitted compounds. Aerosols contain both naturally occurring compounds and those emitted as a result of human activities. Fossil fuel and biomass burning have increased aerosols containing sulfur compounds, organic compounds, and black carbon (soot). Human activities such as surface mining and industrial processes have increased dust in the atmosphere (APCC, 2007). On September 16, 1986, an international treaty was adapted. It is called the Montreal Protocol. The treaty aimed to regulate the production and use of chemicals that contribute to Ozone layer depletion (Britannica, 2017).

Effects of Climate Change on Society

Climate change could cause severe effects to all life forms around our planet. It directly affects the basic elements of people's lives like water, food, health, use of land, and the environment.

With the average global temperature which is predicted to rise by 2 to 3°C within the next fifty years, glaciers will continue to melt faster. Melting glaciers will increase flood risks during the wet season and strongly reduce dry-season water supplies to one-sixth of the world's population, predominantly in the Indian subcontinent, parts of China, and the Andes in South America. Declining crop yields due to drought, especially in Africa, are likely to leave hundreds of millions without the ability to produce or purchase sufficient food. At mid to high latitudes, crop yields may increase for moderate temperature rises (2 to 3°C), but then decline with greater amounts of warming. Ocean acidification, a direct result of rising carbon dioxide levels, will have major effects on marine ecosystems, with possible adverse consequences on fish stocks (Stern, 2007).

Climate change will increase worldwide deaths from malnutrition and heat stress. Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place. Rising sea levels may result in more flooded areas each year with a warming of 3 or 4°C. There will be serious risks and increasing pressures for coastal protection (Stern, 2007).

Ecosystems will be particularly vulnerable to climate change, with one study estimating that around 15-40% of species face extinction with 2°C of warming. The consequences of climate change will become disproportionately more damaging with increased warming. Higher temperatures will increase the chance of triggering abrupt and large-scale changes that lead to regional disruption, migration, and conflict. Warming may induce sudden shifts in regional weather patterns like the monsoons or the El Nino. Such changes would have severe consequences for water availability and flooding in tropical regions and threaten the livelihood of billions. Melting or collapse of ice sheets would raise sea levels and eventually threaten at least 4 million km² of land, which today is home to 5% of the world's population (Stern, 2007).

SUMMARY

Climate change is a worldwide issue that we have to face. Climate change is referred as statistically significant climate variation persisting for an extended period of time. The continuous climate change could bring drastic effects to living and nonliving forms on Earth.

Climate change is brought by several factors like natural processes and persistent human activities. Global warming is one of the major effects of climate change. Global warming threatens all life forms on Earth. It has drastic effects on water availability, food source, health issues, land use, and ecosystem.