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## UNIT V. THE GOOD LIFE

### Overview

In this unit, students will learn the concept of good life and how to achieve it through accompanied discipline and responsibility. A clear distinction between happiness and pleasure will also accomplish under this unit. Students will understand that good life can achieve in society through the use of science and technology usually found in goods, services, and commodities, and by experiencing the *eudaimonia* and green economy.

### Lesson Proper

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#### Content

#### The Good Life

key concepts:

*Virtue* – trait or quality that is deemed morally good and thus, is valued as a foundation of principle.

*Pleasure* – positive, enjoyable, or worth-seeking mental state.

*Happiness* – a state of being that encompasses living a good life with a sense of meaning and deep satisfaction.

*Ethics*- the concept of human morality such as good and evil, right and wrong, justice and crime

*Good* – an object or product that is useful

*Common good* – refers to what is shared and beneficial for all or most members of a given community.

*Intellectual virtues* – excellent personal traits or character strengths which are deemed to be morally good for thinking and learning and are often associated with knowledge and cognitive ability. Intelligent people with high IQ can also become lazy, irresponsible, arrogant, careless, dishonest, or close-minded at the same time. Good thinking and learning require being intellectually careful, honest, with humility, and attentive (intellectual virtues)

#### INTELLECTUAL VIRTUES HAVE THE FOLLOWING KEY FEATURES:

1. They are acquired –No one is born with intellectual virtues. It can obtain through practice guided by instruction.
2. They are excellent character traits – a person with excellent disposition in life possesses Intellectual virtues whether this could be about decision-making or accepting criticisms.
3. They involve human emotions, intentions, motivations, and values. – A person with intellectual virtue does not rejoice with falsehood but loves the truth. If people are

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motivated by truthfulness and honesty, their intentions will also be for the greater good. This reflects the principle that people value in life.

4. They are aimed at cognitive goods. The goals of intellectual virtue are knowledge, truth, and understanding which are the common goods.
5. They are means between two extremes. – intellectual virtues serve as a means between excess and deficiency.

**PLEASURE** – a positive mental state that gives a feeling of satisfaction and enjoyment.

- Satisfying feeling/sensational feelings.
- A significant component of happiness.
- Satisfying wants gives much pleasure to people.
- This feeling is subjective. With different intensities given the same situation.
- Does not last a lifetime.
- Can give a temporary feeling of happiness; the feeling also subsides.
- Unstable and motivated by external factors.

**HAPPINESS** - Constant and generated within.

- State of well-being and contentment that encompasses living a good life with a sense of meaning and deep satisfaction.
- Feeling that people experience when they believe that life is at its best; satisfied with what life brings and offers.
- Product of two aspects: pleasure and a life well-lived (Aristotle).
- Can achieve by eliminating negative pain and displeasure.
- Higher level of satisfaction.
- Not rely on material things but on the experiences of having the materials.
- Happiness can also achieve through actions like kindness, generosity, and love.

**PUBLIC GOOD**

- Defined as an item or service that is consumed without reducing the amount available for others or a commodity or service that is provided without profit to all members of society [Ang, R., Cruz, J., et al. (2018)].

Government or state – pursues public good with a service orientation.

Private corporations – pursue public good with a profit orientation.

There are two concepts of public good:

- Politico-ethical sense & Politico-economic sense

The Public Good from the Politico-Ethical Sense

- National People and the Public Good.
  - Benefits the communal or national public as it is used by a greater number of the local population. Examples of these assumed necessary public services or goods are national defense, education, public health, public ports and highways, social services, and others.

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- Communal People and the Public Good. – people of the community; shared or participated in by the public; communal land. Examples of these are building the playground as a communal project; about a commune or a community; communal life. Community or group of communities may believe that their communal public goods do not jibe- or may conflict with- the national public good.

### THE PUBLIC GOOD FROM THE POLITICO-ECONOMIC SENSE

- Microeconomy
- Macroeconomy

#### TYPES OF PUBLIC GOODS

1. “Public” Public Goods.  
The interests are of not only the individual public but the entire public as well.
2. “Private” Public Goods.  
Set up by the private sector either solely or in participation with the government.
3. “Mixed” Public Goods.  
Mixed in the sense that the undertakers are private groups and yet they seek not profits, hence, service orientated. Sometimes undertaken by some private organizations or civil societies for the common good of the communal or national public.
4. Public “Bads”.  
Negative goods that the general public scorns, and in many cases, are avoided or not tolerated by both the private and public sectors. Some of these are Corruption, pollution, crimes, and the like.

### EUDAIMONIA AND THE COMMON GOOD

- Actualizing through personal development
- Humans are inclined to seek a deeper sense of happiness than mere notions of pleasures and the absence of pain.
- Happiness is that the good life is a life of relationship; a sense of mutual flourishing is embedded in the notion of the common good.

### THE GREEN ECONOMY

- Result of improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities.
- Can be thought of as low carbon resource efficient and socially inclusive.
- Reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services.

How far are we from a “Green Economy”?

*Answer:* Almost every nation, and globally, we are very far from being a green economy.

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## UNIT VI. WHEN TECHNOLOGY AND HUMANITY CROSS

### Overview

Humans began to develop the technology over time to satisfy needs and want in society. The ever-growing economy gave drastic changes in the community. In this lesson students will learn the technology and its impacts on the community, emphasizing the value of human rights despite the ethical dilemma that exists accompanying the emerging technology in society.

### Content

#### **WHEN TECHNOLOGY AND HUMANITY CROSS**

Technology – started as human civilization develop tools necessary for their survival.

- Application of scientific knowledge on different processes that aid in making life easier.
- Both advantages and disadvantages are present despite the good intentions of technological development and advancement.

#### **SOME ADVANTAGES OF MODERN TECHNOLOGY**

1. Improved communication, easy access to information, and social networking.
2. Improved housing, lifestyle, and entertainment.
3. Convenience in Education.
4. Convenience in traveling.
5. Change in the health industry.
6. Efficiency and productivity.
7. Initiates creativity and innovation.

#### **SOME DISADVANTAGES OF MODERN TECHNOLOGY**

1. Job loss and human displacement
2. World destructive weapons.
3. Increased loneliness. - Caused physical isolation which is the absence of interactive relationships between family members and friends at the individual level.
4. Competency – reduces human creativity and intelligence.

### UNIVERSAL DECLARATION OF HUMAN RIGHTS

Under the universal declaration of human rights, the state shall strive to promote and secure the universal and effective recognition of these rights through teaching and providing education [Ang, R., Cruz, J., et al. (2018)].

Some Samples of Human Rights:

1. Right to Equality
2. Freedom from discrimination.
3. Right to life, Liberty, and Personal security.
4. Right to Equality before the Law.
5. Freedom from slavery.
6. Right to own Property.
7. Freedom of Belief and Religions
8. Freedom of Opinion and Information.
9. Right to Marriage and Family.
10. Right to Education.
11. Right to Adequate Living Standard
12. Right to Rest and Leisure.
13. Right to social security.
14. Right, to participate in Government and free elections.
15. Others.

### Emerging Technological Ethical Dilemmas

Some of these are as follows:

1. Real-time Satellite Surveillance Imagery
2. Colonizing Mars: An Astronaut Bioethics
3. Wearable Technology
4. State-sponsored Hactivism and “soft war”.
5. Enhanced Pathogens
6. Non-lethal weapon.
7. Robot swarms
8. Artificial life forms.
9. Resilient social-ecological systems.
10. Brain-to-brain interfaces.

Hence, implying in this unit that when science and technology cross always protect and conserve humanity. Technology must be used to help people and promote the unity and dignity of man.

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## UNIT VII. WHY DOES THE FUTURE NOT NEED US?

### Overview

In the previous units, students have learned the significance of science and technology in society. Students also see the worth of science and technology as great contributors to our nation-building. Thus, it also enlightens the mind on the different scientific ideas that defined society. Furthermore, students examined the evolution of science and technology over time as they learned the historical antecedents of science and technology. Those lessons strengthen their awareness of how science and technology will help you attain a good life and flourish as an individual that is part of the growing society.

Now in this unit, the focus of the study is to understand the role of technology in society thus will give enlightenment and help to assess the functions of science and technology within the community. Moreover, it also allows students to examine technology's potential impact on life.

### Content

#### Why Does the Future Not Need Us?

According to Schultz (2016) cited in the Science, Technology, and Society book for tertiary level, technology had different stages [Ang, R., Cruz, J., et al. (2018)] and these are:

- a. Proto-technology – focuses on the time when early tools were developed before civilization. [Ang, R., Cruz, J., et al. (2018)]
- b. Classical technology- the rise of agricultural technologies and the establishment of communities and cities that enabled the survival of civilization. [Ang, R., Cruz, J., et al. (2018)]
- c. Modern technology – this is fueled by scientific concepts and principles which date back about 500 years ago. [Ang, R., Cruz, J., et al. (2018)]
- d. Postmodern technology. – replaces naturally occurring products with technologically developed ones. Some of the major postmodern technologies include gasoline-powered automobiles including jet engines, other petroleum and its derivatives like synthetic fertilizers, Plastics, PVC (polyvinyl chloride), PCBs (polychlorobiphenyl), chlorofluorocarbons, synthetic detergents, nylon, insecticides (organochlorine compounds; DDT) and plastics (polystyrene and polyesters) and the like [Ang, R., Cruz, J., et al. (2018)].

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Meanwhile, technological advancement affects individuals, animals, and the entire world. Those can give beneficial and non-beneficial effects on humankind. Some give comfort to living: lower sufferings and improve the life of the people, and yet some might cause harm like ozone layer depletion, climate change, nuclear war, war problems, and habitat destruction leading to possible human displacement worst to human extinction.

The following are some modern technological advancements and the impact of possible threats to extinction: [Ang, R., Cruz, J., et al. (2018)]

1. Ozone layer depletion through chlorofluorocarbons
2. Usage of fossil fuels leading to global warming and climate change.
3. Nuclear war and nuclear contamination.
4. Plastics.
5. Petroleum-based fertilizer
6. Habitat destruction.

Technology-driven: Extinction and Displacement - Like any other species on this planet, human beings will tend to become extinct either gradually or suddenly.

Extinction – is the total disappearance of a species.

Two possible scenarios for the gradual extinction of humans:

1. The usual course of life is as individuals age and are replaced by other species more adapted to the changing world.
2. The disappearance of the ecological niche due to the abrupt changes man has inflicted in the ecosystem; the entire population reaches zero reproductive rate.

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## UNIT VIII. TECHNOLOGY AND THE EVOLUTION OF HUMAN SOCIETY

### Overview

In this unit, students will understand the concept of the evolution of human society, the use of technology, and the different classifications of technology according to process including the concepts about society and its classification according to famous writer and futurologist named *Alvin Toffler*. Hence, the student will be gained a deeper understanding of the role of technology in societal development.

## **Content**

### **TECHNOLOGY AND THE EVOLUTION OF HUMAN SOCIETY**

Technology- the application of scientific knowledge to solve a problem

Stages of Evolution of Human Society

1. Hunters and gatherers – members of the society depended solely on the resources available in nature & use tools like stones, wood, bone, and ivory.
2. Shifters and farmers - also called agricultural society; people learned to tame animals and grow crops.
3. Manufacturing and processing- people learned the process of mining using metallic hand tools and stage when people learned to discover coal, gas, and oil which they used in cooking.
4. Future man-made world – technologies are eventually used for producing synthetic food and for recycling resources to satisfy the increasing human needs resulting from the constantly increasing human population

### **Classification of Society Based on Concept of Waves (Alvin Toffler)**

Alvin Toffler – American writer and futurologist

- Focused on technology expansion and its impact on society (called information overload)
1. First wave – one that replaced the hunters and gatherers
    - After the agrarian revolution
    - People during this time used small-scale technologies, which came into existence through trial and error.
  2. The second wave – period of industrial revolution until the end of World War II.
    - Used technologies based on mass production, mass consumption, mass distribution, and weapons of mass destruction combined with standardization, centralization, and synchronization.
  3. Third wave- people used modern technologies based on the advent of science including computers, robotics, and the like.
    - Described as a post-industrialized society after World War II.
    - Associated with scientific-technological evolution.

Classification of technology according to process

1. Energy technology
2. Equipment technology
3. Life Technology
4. Material technology



Technologies keep on changing and these changes are through:

- *Technology substitution* – replacement of technologies
- *Technology diffusion* – technology transfer from one individual to another.

### **National Development through Science and Technology**

Science and technology are instruments of a country's rapid development and economic stability. A nation that does not invest much in science and technology would remain underdeveloped and will be left behind leading to a nation that would never be able to sustain the lives of its people and may have to solely depend on other nations for their basic requirements [Ang, R., Cruz, J., et al. (2018)].

#### **National Development Indicators:**

1. Gross Domestic Product (GDP)
2. Per Capita Income
3. Income Distribution
4. Growth Rate of Gross National Product (GNP)
5. Percentage of Employment
6. Structure of Labor Force
7. Human Life Expectancy
8. Percentage of Urban Population

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## **UNIT IX. BIODIVERSITY AND THE HEALTHY SOCIETY**

### **Overview**

In this unit, students will learn and enjoy the concept of biodiversity and its importance and role in achieving a healthy society. Students will also gain awareness of some of the issues about biodiversity loss and other problems that affect biodiversity and its environment. Under this unit, students will also understand Genetically Modified Organisms (*GMOs*), and their *pros* and *cons* to the users and society. Additionally, the students delve risks and functions of these *GMOs* to fully accomplish and understand a sound and healthy society.

### **Content**

BIODIVERSITY could mean...

- Biological diversity.
- The variety of life in the simplest term.
- A multitude of living organisms and how they interact with each other and their environment.
- This includes the interdependence/interrelationship of all living things in the areas where they live called habitats, whether artificial or natural.

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- Variety of different life forms on earth.

Three (3) components of biodiversity include:

1. *Genetic diversity or diversity of genes* – variation or differences in the genes of a species of individuals.  
Genes – are segments of DNA, which dictate the traits, or characteristics of an organism.
2. *Species diversity or diversity of numbers of species* – This involves a combination of species number (e.g. species richness or evenness).

- Measure whether a particular ecosystem is dominated by a single species or if a similar number of individuals is present.

*Species* – a group of interbreeding organisms with similar structures

3. *Variety of ecosystem or community or ecological diversity* - refers to a variety of ecosystems in a given region.

Ecosystem – biological community including all of the abiotic factors that affect them.

- Biotic (living organism) and abiotic factor (nonliving organism)
- Ecotone – an ecosystem also interacts with another ecosystem in a specific overlapping region.

Importance of Biodiversity

1. Source of food, clothing, shelter, and medicine.
  2. Source of raw materials for industrial activities
- Biodiversity can give different products and goods, clean air and water, and soil.

### Status of Philippine Biodiversity

Hence: Tourists come and go to enjoy diverse Philippine flora and fauna, natural products, and medicine from plants and others. We have rich and diverse flora and fauna which poses an advantage to our natural economy.

Disadvantage: Disturbance in biodiversity and exploitation of these natural resources threatened wild flora and wild fauna.

Threats to biodiversity:

Several factors negatively affect biodiversity. Their effects may be at an organismal level or if on a larger scale, at an ecosystem level [Ang, R., Cruz, J., et al. (2018)].

- Habitat destruction
- Pollution
- Introduction of non-native species and new varieties or Invasive Alien Species (IAS).

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- Some invasive species affecting the aquaculture industry include Janitor fish, clown knife fish, giant snakehead, black-chin tilapia, Jaguar guapote, etc.
- Global climate change
- Exploitation
- Overpopulation

### Conserving Biodiversity

- Through appropriate research, government legislation, education and awareness, and sustainable use of biodiversity.

### Techniques in Conserving Biodiversity

Several technologies are now available to conserve and/or maintain biodiversity. These are as follows:

- Cell and tissue culture.
- Cryopreservation technology. – non-lethal storage of organelles, cells, tissues, or bone biological constructs at ultra-low temperatures.
- Advances in molecular biology and genetics.

### The Role of Evolution in Biodiversity

Evolution – is how the genetic composition of species changes over time. May be microevolution (below species level) and macroevolution (give new rise to new species or larger groups as new genera, families, classes, or phyla). Happens through artificial selection or natural selection. May also be slow or rapid depending on the rate of environmental change, the amount of genetic variation in species, the population size involved, and the generation time of particular species. Speciation and extinction may happen and dictate

*Hence*, in biodiversity adaptation can afford the organism a better chance to survive in its surroundings.

What are GMOs?

- Genetically Modified Organisms
- Organisms with foreign genes incorporated into their genome
- They exhibit different but desirable properties that do not occur naturally by mating and/or natural recombination.
- Genetic modification.
- Can include plants, animals, and microorganisms

Modification of Genes:

- *Transgenic* – organism contains DNA from another species.
- *Cisgenic* – it contains DNA from a member of the same species but doesn't occur naturally.

### *The Making of GMOs, Steps in Cloning*

- Cloning/Genetic Engineering – a technique used to alter or move genetic material (genes) of living cells.
- Restriction Enzymes – an enzyme that cuts the DNA.
- Plasmid – extrachromosomal element capable of independent replication.
- Vector – usually a plasmid or cosmid that accepts foreign DNA and serves as a vehicle for transformation.

### **Process of Cloning:**

It requires a source of DNA or a donor organism. The DNA is cut with restriction enzymes and is ligated to a vector, usually a plasmid, previously cut with another restriction enzyme compatible with the first enzymes used. After ligation, chimeric molecule, molecules are transformed in competent cells and then screened for the presence of genes of interest [Ang, R., Cruz, J., et al. (2018)].

### **Some of the GM crops are listed below:**

1. Corn
  - Bt corn, increase production because of its resistance to the attack of corn borer.
  - With the insertion of a toxin gene from the bacterium (*Bacillus thuringiensis*)
2. Cotton
3. Jatropha
  - Seeds are similar to palm oil.
  - Used as biofuel and a high source of protein for livestock.
4. Rice (Golden Rice)
  - Containing beta-carotene, a precursor of vitamin A.
  - Done to address the pervasive and persistent Vitamin A deficiency problem and more profitable to farmers by adding tungro and bacterial leaf blight (BLB) resistance to this GM crop.
5. Soy
  - Genetically modified to be herbicide resistant.
6. Sugar Beets
  - Grow faster and be resistant to weeds.
  - These "could" have a serious impact on the environment and other crops.
7. Cassava
  - First engineered in 1955, it was virus and pest-resistant but farmers reported that in a few years, the GMO cassava lose its antiviral-resistant quality.
8. Papaya (*Carica papaya* L.)

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- GM papaya lines were developed the resist infection by papaya ringspot virus (PRSV)
- 9. Banana
  - The majority of bananas in the US are genetically modified
- 10. Eggplant
  - Pest-resistant eggplant developed to address eggplant fruit and shoot borer (EFSB) *Leucinodes orboralis*, using modern biotechnological techniques.
- 11. Tomatoes
  - Flavr Savr is the first commercially grown GM tomato granted a license for human consumption.
- 12. Apple
  - Deactivated the gene for polyphenol oxidase (PPO), an enzyme that causes the browning of apples.
- 13. Peas, Yellow crookneck squash or zucchini and Alfalfa

### Impacts of GMOs

Through GM, technologies we achieved the following:

1. "Designer crops" can be produced.
2. Crops with more nutrients, pesticide-resistant, insect resistant, require less inputs to grow and produce more yield.
3. Farmers can have increased income.
4. Include "creating superweeds".
5. In other parts of the world, GMOs are considered to have health threats.
6. Delayed ripening of fruits need in the export market.

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## UNIT X. THE NANO WORLD

### Overview

In this unit, new trends in science and technology called *nanotechnology* will mesmerize the students. Its role in the fast-growing economy will understand upon taking this lesson. Potential uses and applications to the industry and its impacts on society are part of the course. How to address risks will be found in the risk assessment. Students now will have the chance to evaluate the nanotechnology status in the Philippines.

### Content

Key concepts:

- Nanotechnology – a new area of scientific research, which focuses on particles to minutes to be seen but with impact interacting with other fields of sciences.

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- The word nanotechnology is derived from the words nano and technology; nano is one-billionth of a quantity and is represented mathematically as  $1 \times 10^{-9}$  or simply as  $10^{-9}$  and technology generally refers to the application of scientific knowledge for society's practical needs and improvements.
  - "General purpose technology" because of its global impacts and effects.
  - "Enabling technology" because it supports other technologies.
  - Processes that provide goods and/ or services which are derived from matter at the nanometer level" and "principles of engineering the structure of matter at the molecular level.
- Nanomaterials – minute particles.
  - Nanoethics – the study of the ethical and social dimensions of nanotechnology.

According to US National Nanotechnology (NNI), there are four (4) generations of nanotechnology [Ang, R., Cruz, J., et al. (2018)]:

1. Passive nanostructure – size + physical property
2. Active nanodevices – quantum properties
3. Systems of nanosystems – systems of nanodevices
4. Molecular nanosystems – molecular machines and manufacture

### **Some Potential Applications of Nanotechnology:**

1. Energy Storage, production, and conversion. – increasing the electricity generated by windmills. Epoxy-containing carbon nanotubes are being used to make windmill blades.
2. Agricultural productivity and enhancement; vector and pest detection and control. - used nanosensors for faster detection of soil quality and plant health monitoring for improved crop yield. Nanocapsules may also develop for more efficient delivery of herbicides and drugs for livestock.
3. Water treatment and remediation. – Nanoparticles are useful in cleaning up organic chemicals/solvents polluting groundwater. Iron nanoparticles disperse throughout the body of water and decompose the organic solvent in place.
4. Disease diagnosis and screening; drug delivery systems. – Used nanotechnology-based diagnostic kits for screening of diseases and systems of drug delivery will be very useful in health monitoring and cure. One application involves employing nanoparticles to deliver drugs, heat, light, or other substances to specific groups of cells. The particles are manipulated so that they will be attracted to diseased cells, thus allowing direct treatment.
5. Food processing and storage. The use of antimicrobial nanoemulsions will also facilitate the cleaning of food equipment and packing while nanotechnological-based sensors will help in detecting food-borne pathogens.
6. Air pollution and remediation. – Nanoscale metal particles such as FeO and Fe-Ni particles together with iron filings are promising technology for reducing chlorinated solvents, pesticides, and PCBs, which are major environmental contaminants.
7. Construction. – Activities will be a lot easier if nano molecules are used in manufacturing concrete, asphalt, glues, and housing surface.

### **Nanotechnology-based Consumer Products:**

1. Fabric containing silver nanoparticles that kill bacteria making clothing odor-resistant.
2. Skin care products like lotions, sunscreens, and creams use nanoparticles to deliver vitamins deeper into the skin.
3. Lithium-ion batteries that use nanoparticle-based electrodes.
4. Sporting goods like tennis racquets were improved by adding nanotubes to the frames which increase control and power when one hits the ball.
5. Paints are now available which are based on nanomaterials. These paints are deemed solutions to the problem of microbial growth in buildings.
6. Atovi is a nano product from the Philippines. It is a feed formulation and immune enhancer different from the conventional feed mix. It has no medication and nutritional value due to molecular alteration making it more effective at the cellular atomic and sub-atomic structures of an organism.
7. Filtration set-up. The Department of Science and Technology has developed a nano filter assembly for water purification.

### **Risk Assessment and Ethical Considerations**

Nanoethics is the study of the ethical and social dimensions of nanotechnology. Risk sets of issues like security problems, human health and safety, and environmental impact.

Nanotechnology, Dream No More in the Philippines. Nanotechnology seemed to be a dream in the Philippines. Roadmap was formulated by DOST for the development of nanotechnology [Ang, R., Cruz, J., et al. (2018)].

Four (4) Nanotechnology major programs of this roadmap include:

1. Nano-based technologies and materials
2. Nanosensors and nanodiagnostics
3. Nanometrology for ICT and semiconductors; and
4. Nanostructured solar energy devices and storage.

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## **UNIT XI. GENE THERAPY**

### **Overview**

In previous lessons, students learned about biodiversity, GMOs, and Nanotechnologies. Now, students are ready to learn another new trend in science and technology called Gene Therapy. In this lesson, awareness about the positive and negative effects of Gene Therapy will be discussed and how genetic-related diseases can be possibly treated by this new method of curing the diseases, is it helpful or not?

## Content

### Gene therapy

Definition of Terms:

Gene – a part of a cell in a living thing that controls what it looks like, how it grows, and how it develops.

Generic Disorders – a disease that is caused by an abnormality in the individual's DNA.

Vector – An organism that does not cause disease itself, but which carries the DNA from one host to another.

Defective Gene – a gene that does not work properly.

### Gene Therapy

- It was developed in 1972.
- Genetic diseases are treated by repairing the damaged gene responsible for the disease.
- Can cure diseases like cystic fibrosis and hemophilia.
- It can cause susceptibility to some cancers.
- Remain risky and still under study to make sure that it will be safe and effective.

### Delivery of Genes During Gene Therapy

There are several ways by which therapeutic genes are delivered to the body. The cells with the defective gene are taken from the body and the therapeutic gene is either "spliced" or injected into these cells. They are left to grow in the laboratory and then returned to the person. The techniques used are as follows [Ang, R., Cruz, J., et al. (2018)]:

1. Use of vector
2. Use of stem cells

### Two (2) Types of Gene Therapy

1. Somatic gene therapy
  - If the cell to be treated is any cell of the body aside from sperm or egg cell.
  - Divided into two categories:
    - a. *Ex vivo gene therapy* – modifies the cells outside the body and transplanted them back after selection and amplification.
    - Advantage includes the ability to target selectively specific cell types for the production of the gene of interest before engrafting the cells into the host.
    - The disadvantage is that it is an intrinsically more invasive process than an injection of vector suspensions in "in vivo" gene therapy.
    - b. *In vivo gene therapy* – involves the direct introduction of genetic materials into the human body. Applied to many tissues of the human body.



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- Simple because it is accomplished by the single step of direct vector injection into the desired target organ and is minimally invasive.
  - Disadvantage it is possible to cause toxicity and elicit immune responses.
2. Germline Gene Therapy
- Cells are modified by the introduction of functional genes into their genomes.
  - Not allowed to be done in humans, because of ethical issues and fear of altering the human genes.

### Problems Associated with Gene Therapy:

1. Gene therapy is short-lived in nature; thus, patients will have to undergo multiple rounds of gene therapy.
2. When the defense is low due to gene therapy there is a risk of further advancement in the illness.
3. Viral vectors could disrupt vital genes resulting in another disease.
4. There is an occurrence of multi-gene disorders.
5. The therapeutic gene might be slotted into the wrong spot.
6. Other genes may be accidentally delivered to the cell.
7. The deactivated virus may be contagious.

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