LEARNING GUIDE:

* DESCRIBE BIOTECHNOLOGY
  + biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet.
  + Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes.
  + Biotechnology helps heal the world:
    - Biotech has revolutionized the healthcare industry by enabling the development of new drugs, medical devices, and diagnostic tests that improve human health and save lives. In this article, we will discuss how biotechnology helps the world in terms of its medical applications.
    - Medical biotechnology has improved tremendously in the recent decades, which lead to the multiple innovative techniques that aim to prevent, diagnose and treat diseases. More advanced and innovative methodologies include genomics, pharmaceuticals, DNA sequencing, cell culture, interference RNA, and genome editing have effectively improved the growth and understanding of health science, through gene sequencing, stem cells for regenerative medicine, tissue engineering, and antibiotics. (Biolyse, 2018)
    - APPLICATIONS OF BIOTECHNOLOGY IN MEDICINE:
      * With its integra­tion with nanotechnology, Nano-materials and information technology has led to the devel­opment of innovative and revolutionary appli­cations in health care. Nowadays health care Biotech products and techniques are being implemented in various areas of health care, including: biopharmaceuticals, drug delivery systems, diagnostic testing, tissue replace­ment, etc. (Parman, n.d.)
      * BIOPHARMACEUTICALS:
        + Biopharmaceuticals for treating ailments were manufactured swiftly and safely using cutting-edge biotechnology techniques. Additionally, biopharmaceuticals use specific organisms to successfully create the medication rather than any chemicals. Biopharmaceuticals typically begin as large protein molecules. When they are within the human body, they hunt down and destroy the disease's deadly and covert components. Today, scientists and researchers are working to improve and create biopharmaceutical medications that can be used to treat cancer, hepatitis, and heart disease. (Biolyse, 2018)
      * PHARMACOGENOMICS:
        + Pharmacogenomics is a method that uses a person's genetic information to determine the most effective biotechnology treatment for their ailment. This research examines how the body reacts to various drugs. Simply put, this is the result of recent developments in genetics and drugs. The ultimate goal of this application is to enhance medications that are individually targeted to a person instead of his genetic composition to assure appropriate illness treatment. The ultimate goal of this field of medicine is the efficient production of biotechnological drugs that are administered to patients in accordance with their genetic make-up. (Biolyse, 2018)
        + Pharmacogenomics allows medical firms to create medications that are dependent on the proteins, chemicals, and RNA particles depending on the selected characteristics and infections that are relevant. Drugs that have been synthesized almost always have better curative effects and do less harm to neighboring cells. Specialists can determine how well a patient's body can prepare and digest a drug and determine the proper amount of medication dosages by knowing the person's inherited propensities. As a result, a precise prescription will be issued and the likelihood of an overdose is reduced. (Biolyse, 2018)
      * RAPID DEPLOYMENT OF VACCINE
        + Global pandemics are a genuine problem that have historically shown how powerfully they can grasp humanity. Researchers and scientists can swiftly identify the precursors or signs that can lead to serious illnesses and diseases thanks to biotechnology. They are therefore able to produce vaccines against any serious pandemic disease swiftly. Biotech companies are developing new vaccines and treatments for diseases such as HIV, Ebola, and COVID-19. For example, the COVID-19 vaccine developed by Pfizer-BioNTech and Moderna uses messenger RNA (mRNA) technology, a biotech innovation that allows for the rapid development of vaccines. (Biolyse, 2018)
      * OTHER APPLICATIONS:
        + Stem Cell Treatments
        + Monoclonal Antibodies for Therapy
        + Genome Sequencing
        + Gene Therapy Drugs
      * CONCLUSION:
        + As a result of enabling the creation of novel medications, medical tools, diagnostic tests, regenerative medicine, personalized medicine, and therapies for infectious diseases, biotechnology has fundamentally changed the healthcare sector. Numerous lives have been saved and patient outcomes have improved thanks to biotech breakthroughs. Biotechnology will continue to play a significant role in enhancing human health and wellbeing with sustained research and development.
  + Biotechnology contributes to the world's energy needs:
    - Industrial Biotechnology
      * Utilizing biological resources for the processing and manufacture of enzymes, chemicals, materials, and energy is known as industrial biotechnology. The use of sustainable alternatives to fossil fuels in the production of common goods as well as the discovery of ground-breaking techniques and pathways to achieving entirely new functionalities and performance are recognized as contributing to addressing significant societal challenges. (Staff, 2021)
    - Biotech transforms bacteria into tiny manufacturing facilities by using biological processes like fermentation and biocatalysts like enzymes, yeast, and other microbes. In order to fuel the globe, biotech:

1. reduces the number of steps in chemical manufacturing processes by at least 80%.
2. reduces the temperature at which clothing is cleaned, potentially saving $4.1 billion yearly.
3. increases the effectiveness of the production process to reduce operating expenses by at least 50%.
4. Lowers the dependency on and use of petrochemicals.
5. reducing greenhouse gas emissions by at least 52% with biofuels.
6. reducing trash production and water use.
7. maximizes the use of conventional biomass waste materials.

(Biolyse, 2018)

* + - Benefits of Industrial Biotechnology:
      * Sustainable Production: Industrial biotechnology can substitute more environmentally friendly processes for conventional industrial ones that depend on fossil fuels and other non-renewable resources. For instance, biotechnology can be utilized to create sustainable biofuels that generate fewer greenhouse emissions than fossil fuels. Additionally, it can be applied to the production of biodegradable plastics and other materials that can be discarded without endangering the environment.
      * Waste reduction: By developing goods and procedures that produce less waste or are made to be recycled, industrial biotechnology can lower waste. Enzymes created by biotechnology, for instance, can be utilized in the manufacture of paper to cut down on waste. Biotechnology can also be utilized to manufacture new materials from waste resources, such as biofuels from agricultural waste or enzymes for use in industrial processes from food waste.
      * Industrial biotechnology can develop novel goods and procedures that are not feasible using conventional industrial techniques. For instance, specific compounds, flavors, and perfumes that are difficult or expensive to generate using conventional techniques can be produced utilizing biotechnology. New materials, including bio-based polymers and fibers, can also be produced using it.
* HISTORY OF BIOTECHNOLOGY
  + ANCIENT BIOTECHNOLOGY (Pre-1800)
    - 'Discoveries' or 'developments' can be used to describe the majority of ancient developments, or those that occurred before the year 1800. If we examine all of these innovations, we may draw the conclusion that they were all founded on usual natural observations that could be tested for the improvement of human existence at the time.
    - Domestication of food products (AGRICULTURE)
      * Since the beginning of man and for as long as people have existed, food has been a necessity. Every time a dead animal was discovered, early man would consume it raw. However, there was a lack of food when the weather was harsh, and as the proverb goes, "necessity is the mother of all inventions," this led to the domestication of food products, often known as "agriculture." (Ashish Swarup Verma, 2011)
      * They were aware of the significance of water, light, and other conditions for the healthy development of food plants. They also began domesticating various wild animals based on similar concepts and demands, which helped them to enhance their living conditions and satisfy their hunger. (Ashish Swarup Verma, 2011)
      * After the domestication of wild animals and food crops, man turned his attention to other novel observations, such as cheese and curd. Cheese, which was made by adding rennet (an enzyme found in a calf's stomach) to sour milk, which is only possible by exposing milk to microbes, can undoubtedly be considered as one of the first direct products (or by-products) of biotechnology, even though this understanding was not present at the time. (Ashish Swarup Verma, 2011)
      * One of the first bacteria that people have used to their advantage is yeast. The manufacture of vinegar, bread, and other items involving fermentation, such as alcoholic drinks like whisky, wine, and beer, all include the usage of yeast. (Ashish Swarup Verma, 2011)
  + CLASSICAL BIOTECHNOLOGY
    - 'Classical Biotechnology' refers to the second stage of biotechnology's evolution and development. From 1800 to roughly the middle of the 20th century, this era was in existence. During this time, a variety of sightings with supporting scientific data began to flow in. (Ashish Swarup Verma, 2011)
    - The fundamentals of genetic information transfer are the basis of biotechnology. This was first understood in plants, specifically Pisum sativum, also known as the pea plant. Gregor John Mendel (1822–1884), an Austrian Augustinian monk, deciphered these observations. Mendel gave the Natural Science Society in Brunn, Austria, a presentation on the "Laws of Inheritance" at that time. (Ashish Swarup Verma, 2011)
    - Mendel's findings was confirmed in 1900, about 34 years after his passing, by researchers including Hugo de Vries, Erich Von Tschermak, and Carl Correns. Mendel's research went overlooked for such a long time because Charles Darwin's Theory of Evolution was so popular at the time that it overshadowed the importance of Mendel's work. (Ashish Swarup Verma, 2011)
    - 1868, Nearly simultaneously with Robert Brown's discovery of the cell nucleus, Swiss biologist Fredrich Miescher published nuclein, a substance made of nucleic acid that he recovered from pus cells, or white blood cells (WBC). Due to the identification of DNA as a genetic substance and its function in the transmission of genetic information, these two discoveries formed the cornerstone of contemporary molecular biology. (Ashish Swarup Verma, 2011)
    - 1881, Robert Koch, a German physician described the bacterial colonies growing on potato slices (First ever solid medium). (Ashish Swarup Verma, 2011)
  + MODERN BIOTECHNOLOGY
    - The Second World War became a significant barrier to scientific advancement. Following the end of World War II, numerous highly significant findings were made public, paving the way for contemporary biotechnology and its current state. (Ashish Swarup Verma, 2011)
    - In 1953, JD Watson and FHC Crick provided a structural model of DNA, popularly known as the "Double Helix Model of DNA", which for the first time explained the puzzles surrounding DNA as a genetic material. (Ashish Swarup Verma, 2011)
    - Later, in 1961, Jacob and Monad introduced the idea of Operon.
    - In 1975 Kohler and Milestein discovered the concept of cytoplasmic hybridization and produced the first ever monoclonal antibodies which revolutionized diagnostics. (Ashish Swarup Verma, 2011)
* PROS AND CONS OF BIOTECHNOLOGY
  + PROS:

1. Improves nutritional intake and reduces hunger - Our food supply now contains more nutrients because to biotechnology. Croplands can create essential vitamins and minerals, which decreases health problems caused by nutrient deficiencies. People can consume less and still get the same nutritional benefits thanks to biotechnology, which also increases farmland yields and nutritional density. Consequently, more individuals can obtain the food they require. Croplands can produce food with the use of biotechnology that might not be achievable under "regular" circumstances. It is feasible to cultivate crops in the desert by using theories from this field of study. Crops that are naturally pest-resistant can be developed.
2. Promotes medical advancements - With the help of biotechnology, we can seek internal advancement just as easily as we can go externally. Human genome research has helped us better understand hereditary disorders and some malignancies, leading to the development of more effective - and occasionally curative - treatments. In order to comprehend the significance of folic acid, it has enabled us to investigate the causes of some birth abnormalities. As a result, typical human lifespans can be increased. We have developed vaccinations with the use of biotechnology. It has aided in our ability to develop medicines that lessen challenging disease symptoms. Even the knowledge of how contagious diseases spread has been useful in preventing their spread.
3. Reduces waste and preserves our resources - We have the chance to increase the shelf life of our food sources thanks to biotechnology. Food preservation methods like salting have been used since before the time of the Bible. Food preservation techniques like freezing and drying have been around for a very long time. According to National Geographic, human waste has a significant impact on the environment. Pasteur invented a method of heating food goods to remove dangerous substances so they can be maintained for a long time. The United States produced 251 million tons of rubbish in 2006. That comes out to around 5 pounds of garbage per person, every day. Homes generate 65% of waste, and 55% of that waste will be dumped in a landfill. Biotechnology allows us to create waste products that have better biodegradable properties. It allows us to manage landfills more effectively. That way we can begin to minimize the footprint being left for future generations.
   * CONS:
4. Ethical issues: Because it involves the manipulation and modification of living things, biotechnology creates ethical issues. For instance, discussions over the safety of genetically modified organisms (GMOs), potential environmental effects, and unforeseen repercussions have been prompted by GMOs. The employment of biotechnology in fields like human cloning and genetic engineering is likewise surrounded by ethical questions.
5. Safety concerns: A major worry is the safety of biotechnology goods and procedures. Despite thorough testing and established regulatory frameworks, unanticipated hazards or unexpected outcomes can always occur. For example, the introduction of genetically modified organisms into the ecosystem may have unforeseen ecological effects or result in the introduction of changed genes into wild populations.
6. Environmental effects: Biotechnology, particularly when used in agriculture, may have adverse effects on the environment. Herbicides and pesticides used in conjunction with genetically modified crops may have unforeseen consequences for ecosystems, soil health, and biodiversity. Additionally, the development of biofuels may result in alterations to land usage and deforestation, both of which may have detrimental effects on the environment.