



Mains Practice Question

Q. What are the potential applications of genetic engineering in agriculture, medicine, and environmental conservation? What ethical concerns do these advancements raise? **(250 words)**

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Approach

- Introduce the answer with definition of genetic engineering
- Highlight potential applications of genetic engineering
- Mention ethical concerns related to genetic engineering
- Conclude positively.

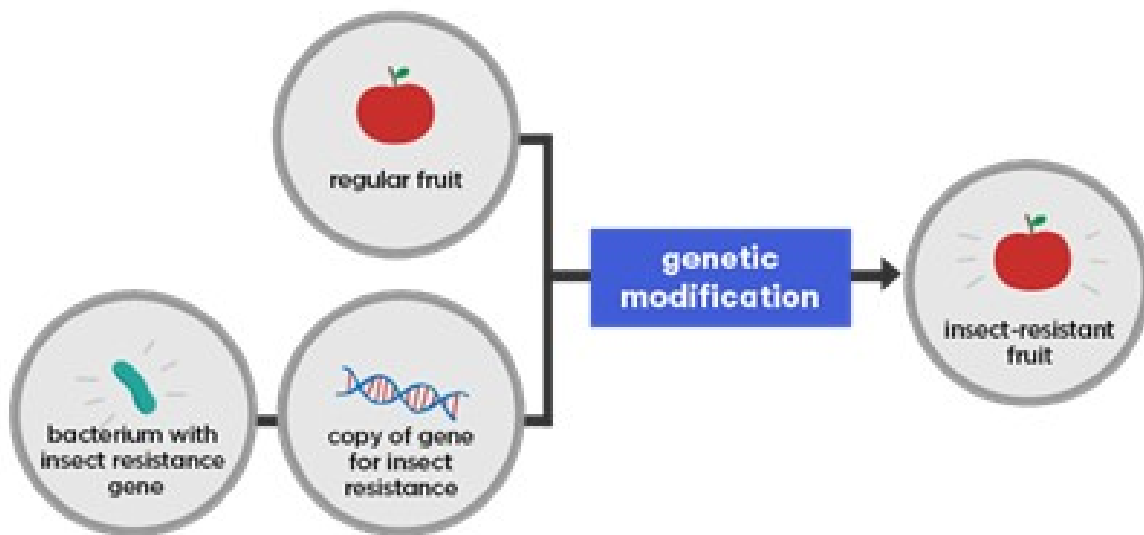
Introduction

Genetic engineering is the process of manipulating an organism's genetic material, typically by **inserting or deleting specific genes**, to achieve desired traits or characteristics. It holds immense promise for agriculture, medicine, and environmental conservation.

Body

Potential Applications of Genetic Engineering:

- **Agriculture:**
 - **Reduced Reliance on Pesticides:** Engineering pest-resistant crops like **Bt cotton** minimizes the use of harmful insecticides, safeguarding human health and the environment.
 - **Enhanced Food Security:** Engineering crops resistant to diseases (e.g., **Papaya ringspot virus-resistant papaya**) reduces crop loss and increases food production, vital for feeding a growing global population.
 - China is planting **salt-tolerant GM rice** in a salty region on the edge of the **Xinjiang desert**, where most vegetation can't grow to promote food security.



- **Improved Nutritional Value:** Genetically modified crops can be enriched with essential vitamins and minerals, addressing malnutrition, particularly in developing nations.
 - For example, **Golden Rice** is engineered with increased **beta-carotene** to combat Vitamin A deficiency.
- **Improved Shelf Life:** Introducing genes that slow down spoilage can extend the shelf life of fruits and vegetables, reducing food waste and ensuring wider availability of fresh produce.
- **Medicine:**
 - **Gene therapy:** Genetic engineering can potentially treat or cure genetic disorders by introducing **functional genes or correcting defective ones**.
 - Trails for gene therapy for **cystic fibrosis** are going on.
 - **Pharmaceutical production:** Genetically engineered bacteria, yeast, or plants can produce therapeutic proteins, vaccines, and antibodies more efficiently.
 - For example, **yeast** can produce human insulin for diabetics, a significant advancement over animal-derived insulin.
 - **Sickle Cell Disease:** Gene editing techniques are being explored to correct the defective gene responsible for **sickle cell disease**.
 - **Cancer Treatment:** Research is ongoing to use **CAR-T cell therapy**, where a patient's **T cells** are genetically modified to recognize and attack cancer cells.
- **Environment Conservation:**
 - **Bioremediation:** Plants can be genetically modified to absorb pollutants from soil and water, contributing to environmental cleanup efforts.
 - Studies are ongoing to explore the use of **genetically modified Brassica juncea (Indian mustard)** for the bioremediation of soils.
 - Microorganisms engineered to **metabolize oil** can be used to clean up oil spills, minimizing environmental damage.
 - **Conservation of Endangered Species:** Gene banks can store genetic material from endangered species, and genetic engineering techniques may be used to:
 - Introduce genes from closely related species to bolster genetic diversity in small, isolated populations of endangered animals.
 - **Development of Eco-friendly Products:** Genetically engineered organisms can produce:
 - **Biodegradable Plastics:** Microbes can be engineered to create biodegradable plastics that decompose naturally, **reducing plastic pollution**.
 - **Biofuels:** Engineered **algae or yeast** can be used to produce biofuels as a renewable and sustainable energy source.

Ethical Concerns Related to Genetic Engineering:

- **Impact on Biodiversity:** Reliance on a few high-yielding GM varieties can reduce agricultural diversity, making crops more vulnerable to widespread diseases like the **Irish Potato Famine**.

- **Human Enhancement:** The possibility of using gene editing for non-therapeutic purposes, such as enhancing intelligence or athletic performance, raises ethical questions about creating "**designer babies**"
- **Inequitable Access:** The high costs associated with these new technologies could limit access for patients in developing nations, exacerbating **existing healthcare disparities**.
- **Ownership and Control:** Genetic engineering raises questions about ownership and control of genetic information, **patents on genetically modified organisms**, and the commercialization of genetic technologies.

Conclusion

To address these ethical concerns, principles such as **beneficence, non-maleficence, autonomy, and justice** should guide the development and application of genetic engineering technologies to ensure **responsible and equitable use** for the greater **good of humanity and the environment**.

PDF Reference URL: <https://www.drishtias.com/mains-practice-question/question-8278/pnt>

