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Q15

What are the research and developmental achievements in applied biotechnology/? How will these achievements help to uplift the poorer sections of the society?

UPSC Civil Services Mains 2021 · GS III · 15 marks · Indian Economy

Indian Economy and issues relating to planning, mobilization of resources, growth, development and employment.

Core demand of the question

- What are the research and developmental achievements in applied biotechnology? How will these achievements help to uplift the poorer sections of the society?
- Keep the explanation within a 15-mark length

Revision summary

Applied biotech in India includes vaccines, PCR and rapid tests, **tissue culture**, bio-inputs, biosimilars, and **Bt cotton**.

Public marker-assisted breeding and livestock vaccines are as important as GM headlines.

The poor gain first from cheap immunisation and diagnostics, then from clean seed and climate-tolerant varieties.

Bt cotton's income gain was real in some years and later limited by resistance and costs.

Without extension, water, and markets, lab achievements stay in journals.

Introduction

Applied biotechnology is the use of cells and molecules to make seed, vaccines, diagnostics, enzymes, and bio-inputs. India has real achievements in vaccines, diagnostics, **tissue culture**, and **Bt cotton**. These can lift the poor when they cheapen calories, health, and farm risk. They do not lift the poor when patents, irrigation, and extension stay out of reach.

Body

Research and development achievements

- **Vaccines:** India is a large producer of **WHO-prequalified** vaccines (including pentavalent, rotavirus, and later COVID platforms). **Recombinant hepatitis B** and indigenous rotavirus strains are public-health biotech, not only a private brand story.
- **Diagnostics:** ELISA, PCR, and rapid antigen platforms scaled for **TB, HIV, and COVID**. Cheaper tests matter more to the poor than a new luxury drug.
- **Bt cotton:** the main commercial GM crop in India. It cut bollworm losses in many years of the 2000s. **Pink bollworm resistance** later showed that one gene is not a permanent harvest.
- **Tissue culture:** banana, potato, and sugarcane planting material raised yields for small growers who can buy clean seed.

- **Biofertilisers, biopesticides, and fermentation:** rhizobium, trichoderma, and industrial enzymes for food and feed.
- **Medical biotech:** recombinant **insulin**, biosimilars, and public-sector work on affordable biologics.
- **Public research:** ICAR, DBT, CSIR, and universities on **marker-assisted breeding**, drought and salt lines, and livestock vaccines (for example classical swine fever and veterinary diagnostics).
- **GM mustard and other food GM** remain politically contested; achievement should not be written as if every file is already in the field.

How this can uplift poorer sections

- **Cheaper vaccines and diagnostics** cut death and out-of-pocket shock, which is the most direct biotech-to-poverty channel.
- **Clean planting material and bio-inputs** raise small-farm output without the full chemical bill when extension is honest.
- **Bt cotton** raised incomes for many commercial smallholders in some periods; it also raised seed cost and did not remove **monsoon and price** risk. Uplift was real and partial.
- **Drought- and flood-tolerant varieties** (conventional plus molecular markers, not only GM) protect the poorest rainfed plots first.
- **Livestock and fish vaccines** protect the asset base of pastoral and small dairy households.
- **Skills and MSME fermentation** (enzymes, spawn, tissue-culture nurseries) can be rural jobs if quality regulation holds.
- **Nutrition:** biofortified zinc wheat and iron pearl millet from public breeding help hidden hunger cheaper than a capsule campaign.

Conditions so the poor actually gain

- Public procurement of vaccines and seed, **DBT-ICAR extension**, and regulation that keeps **spurious kits and illegal GM** out.
- Do not equate every lab press note with a poor household's plate.
- Pair biotech with **credit, water, and MSP or deficiency payments**, or the extra quintal still sells in a crash.

Flow diagram

Applied biotech -> Vaccines diagnostics
 Applied biotech -> Seed tissue culture Bt
 Vaccines diagnostics -> Lower health shock
 Seed tissue culture Bt -> Farm output and less pest loss
 Price water extension -> Uplift of poorer households
 Lower health shock -> Uplift of poorer households
 Farm output and less pest loss -> Uplift of poorer households

Conclusion

India's applied biotech record is strongest in vaccines, diagnostics, **tissue culture**, and a mixed Bt-cotton lesson. Those tools uplift the poor when they are cheap, public, and bundled with water and markets. A gene without an extension worker is not a social policy.

Facts & figures

Bt cotton

India's principal commercial GM crop; early bollworm control, later pink bollworm resistance in parts.

Vaccine manufacturing

Large WHO-prequalified capacity, including rotavirus and routine childhood antigens, plus COVID-era scale-up.

Marker-assisted selection

Molecular breeding used in public institutes to move drought, flood, and disease traits without always using transgenes.

Tissue culture

Mass clean planting material for banana and other crops used by small commercial growers.

DBT / ICAR / CSIR

Public biotech and agricultural research system that still supplies most poor-farmer varieties.

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