

Biotechnology, as you would have learnt from the previous chapter, essentially deals with industrial scale production of biopharmaceuticals^{drugs} and biologicals using genetically modified microbes, fungi, plants and animals.^{drugs} The applications of biotechnology include therapeutics, diagnostics, genetically modified crops for agriculture, processed food, bioremediation, waste treatment, and energy production. Three critical research areas of biotechnology are:

- (i) Providing the best catalyst in the form of improved organism usually a microbe or pure enzyme.

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- (ii) Creating optimal conditions through engineering for a catalyst to act, and
- (iii) Downstream processing technologies to purify the protein/organic compound.

Let us now learn how human beings have used biotechnology to improve the quality of human life, especially in the field of food production and health.

10.1 BIOTECHNOLOGICAL APPLICATIONS IN AGRICULTURE

Let us take a look at the three options that can be thought for increasing food production

- (i) agro-chemical based agriculture;

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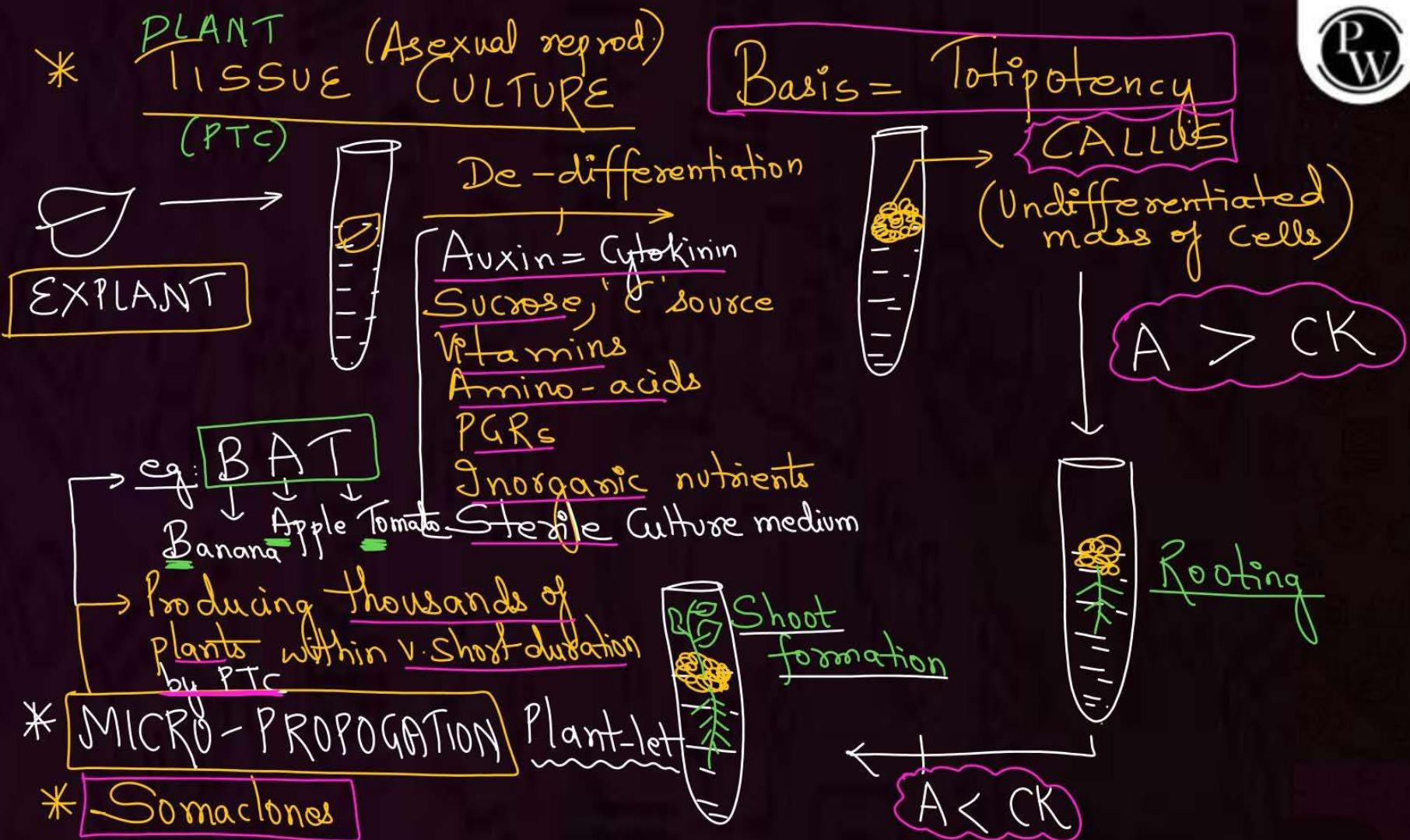
- (ii) organic agriculture; and (Biofert.)
(iii) genetically engineered crop-based agriculture.

The **Green Revolution** succeeded in tripling the food supply but yet it was not enough to feed the growing human population. Increased yields have partly been due to the use of improved crop varieties but mainly due to the use of better management practices and use of agrochemicals (fertilisers and pesticides). However, for farmers in the developing world, agrochemicals are often too expensive, and further increases in yield with existing varieties are not possible using conventional breeding.

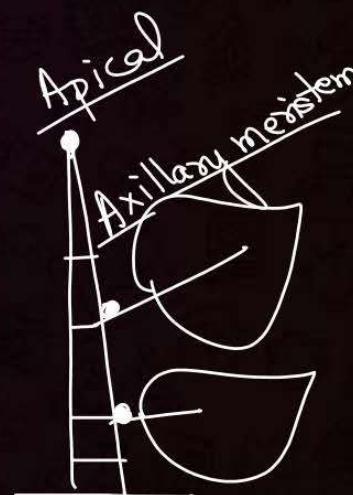
As traditional breeding techniques failed to keep pace with demand and to provide sufficiently fast and efficient systems for crop improvement, another technology called **tissue culture** got developed. What does tissue culture mean? It was learnt by scientists, during 1950s, that whole plants could be regenerated from **explants**, i.e., any part of a plant taken out and grown in a test tube, under sterile conditions in

Father of Green Rev → Norman E. Borlaug
" " Indian " " → M-S. Swaminathan

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special nutrient media. This capacity to generate a whole plant from any cell/explant is called **totipotency**. You will learn how to accomplish this in higher classes. It is important to stress here that the nutrient medium must provide a carbon source such as sucrose and also inorganic salts, vitamins, amino acids and growth regulators like auxins, cytokinins etc. By application of these methods it is possible to achieve propagation of a large number of plants in very short durations. This method of producing thousands of plants through tissue culture is called **micro-propagation**. Each of these plants will be genetically identical to the original plant from which they were grown, i.e., they are **somaclonies**. Many important food plants like tomato, banana, apple, etc., have been produced on commercial scale using this method. Try to visit a tissue culture laboratory with your teacher to better understand and appreciate the process.



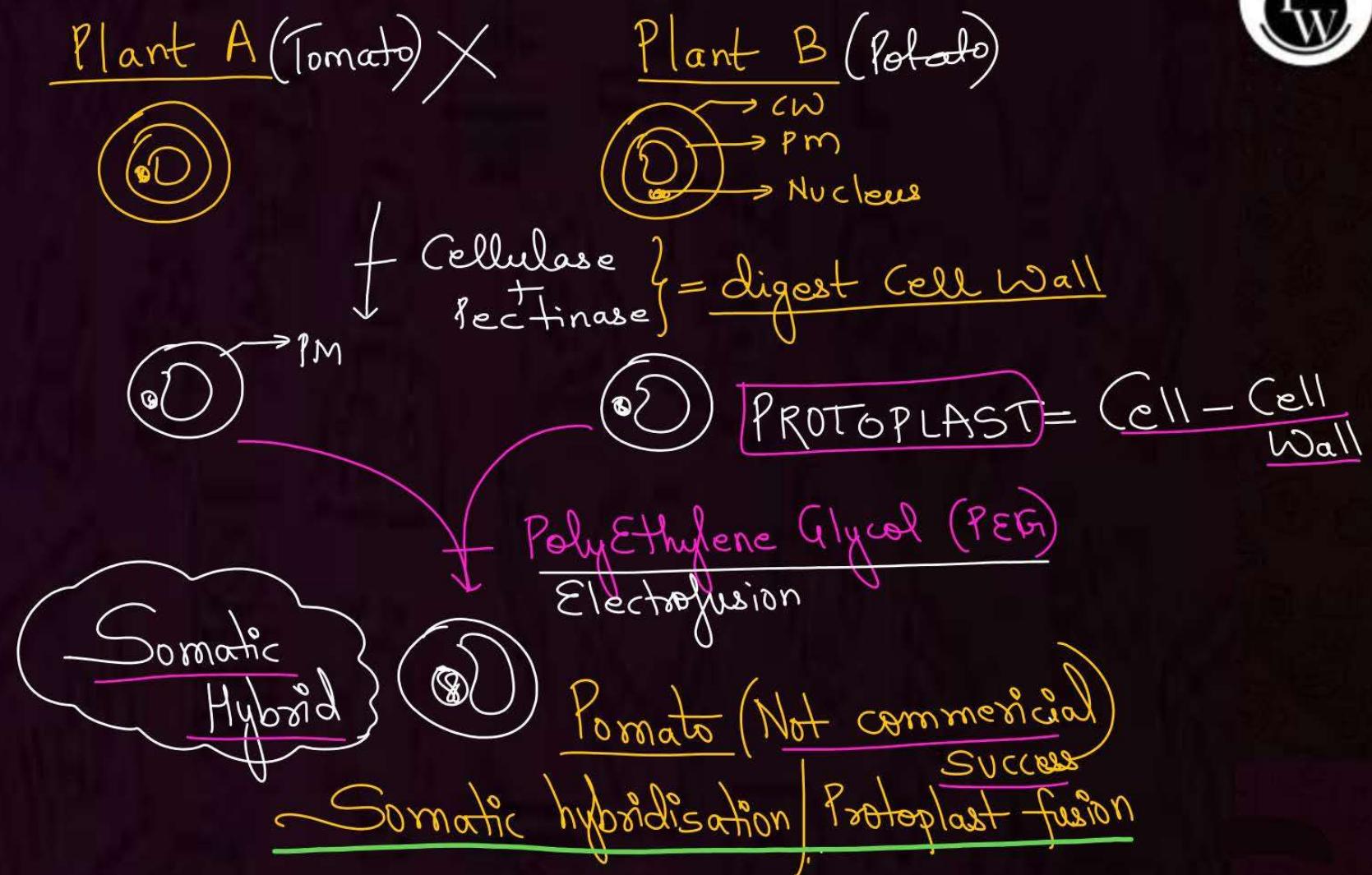
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Another important application of the ~~method~~ is the recovery of healthy plants from diseased plants. Even if the plant is infected with a virus, the **meristem** (apical and axillary) is free of virus. Hence, one can remove the meristem and grow it *in vitro* to obtain virus-free plants. Scientists have succeeded in culturing meristems of banana, sugarcane, potato, etc.



Scientists have even isolated single cells from plants and after digesting their cell walls have been able to isolate naked protoplasts (surrounded by plasma membranes). Isolated protoplasts from two different varieties of plants – each having a desirable character – can be fused to get hybrid protoplasts, which can be further grown to form a new plant. These hybrids are called **somatic hybrids** while the process

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is called **somatic hybridisation**. Imagine a situation when a protoplast of tomato is fused with that of potato, and then they are grown – to form new hybrid plants combining tomato and potato characteristics. Well, this has been achieved – resulting in formation of pomato; unfortunately this plant did not have all the desired combination of characteristics for its commercial utilisation.

Is there any alternative path that our understanding of genetics can show so that farmers may obtain maximum yield from their fields? Is there a way to minimise the use of fertilisers and chemicals so that their harmful effects on the environment are reduced? Use of genetically modified crops is a possible solution.

Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called **Genetically Modified Organisms (GMO)**. GM plants have been useful in many ways. Genetic modification has:

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- (i) made crops more tolerant to abiotic stresses (cold, drought, salt, heat).
- (ii) reduced reliance on chemical pesticides (pest-resistant crops).
- (iii) helped to reduce post harvest losses.
- (iv) increased efficiency of mineral usage by plants (this prevents early exhaustion of fertility of soil).
- (v) enhanced nutritional value of food, e.g., golden rice, i.e., Vitamin 'A' enriched rice.

In addition to these uses, GM has been used to create tailor-made plants to supply alternative resources to industries, in the form of starches, fuels and pharmaceuticals.

Some of the applications of biotechnology in agriculture that you will study in detail are the production of pest resistant plants, which could decrease the amount of pesticide used. Bt toxin is produced by a bacterium called **Bacillus thuringiensis** (**Bt** for short). Bt toxin gene has been cloned from the bacteria and been expressed in plants to provide

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1. GOLDEN RICE

PYO
Vit-A Enriched

* Oryza sativa (= Rice)
Cell

Host
Transgenic
GMO

= Desired gene
 β -carotene gene from Carrot / Daffodil

P_{pro}-Vit-A

Vector
= Ti plasmid of A. tumefaciens

PTC

Golden Rice

PYO
out of NCF

Prevent Night-blindness in developing countries

* Bt Cotton / Bt Plants P
W

Pest-resistant / Bioinsecticide
 Biopesticide / Insect-resistant
 Insecticidal plant

- Cotton bollworm (Insect) → destroy cotton bolls → ↓↓ yield of cotton

- Bacillus thuringiensis (Bacteria)

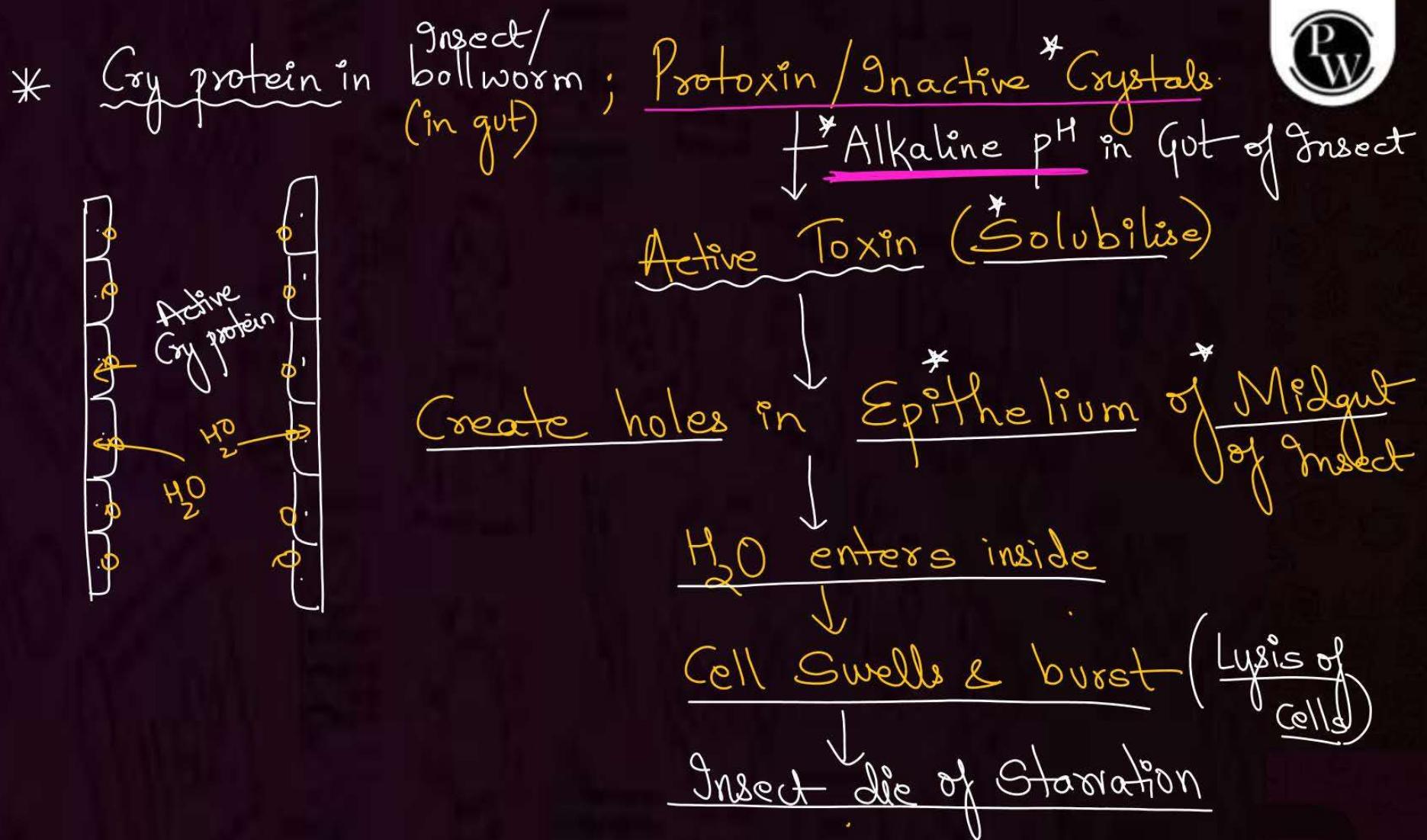
Bt Gene / Cry gene

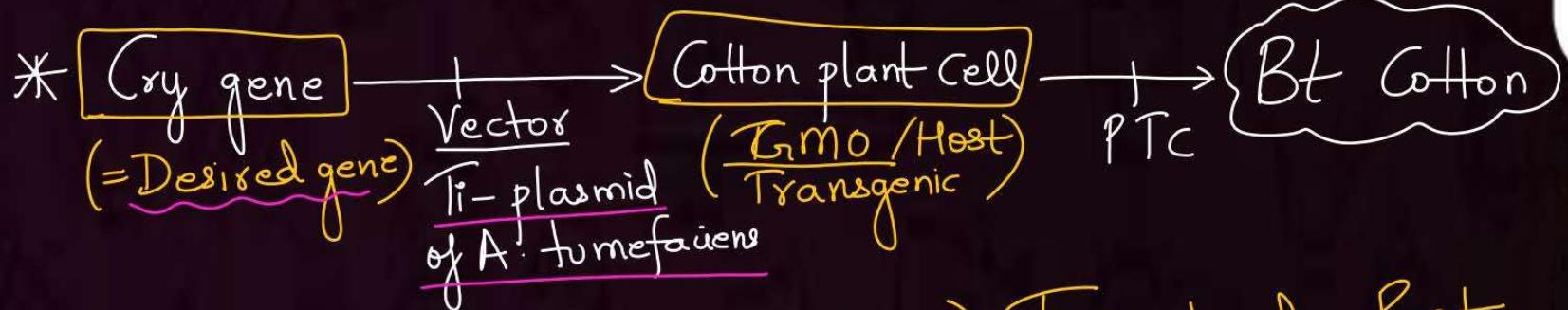
↓
During Sporulation phase

Bt protein / Cry protein
 in form of crystals

Present as Pro-toxin
In inactive form

↓
do not kill bacteria





* Choice of Gene depends a) Targeted Pest

e.g. a) Cotton bollworm :- Cry IAc and Cry IIAb

b) Corn borer :- Cry IAAb

* Toxic Cry gene Insect-group Specific

- Orders {
 a) Lepidopterans : Tobacco budworm, Armyworm
 अक्षम b) Coleopterans : Beetles
 c) Dipterans : Flies, Mosquitoes

resistance to insects without the need for insecticides; in effect created a bio-pesticide. Examples are Bt cotton, Bt corn, rice, tomato, potato and soyabean etc.

Bt Cotton: Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes). *B. thuringiensis* forms protein crystals during a particular phase of their growth. These crystals contain a toxic **insecticidal protein**. Why does this toxin not kill the *Bacillus*? Actually, the Bt toxin protein exist as inactive *protoxins* but once an insect ingest the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals. The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect.



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Specific Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the several crop plants such as cotton (Figure 10.1). The choice of genes depends upon the crop and the targeted pest, as most Bt toxins are insect-group specific. The toxin is coded by a gene *cryIAc* named **cry**. There are a number of them, for example, the proteins encoded by the genes *cryIAc* and *cryIIAb* control the cotton bollworms, that of *cryIAb* controls corn borer.



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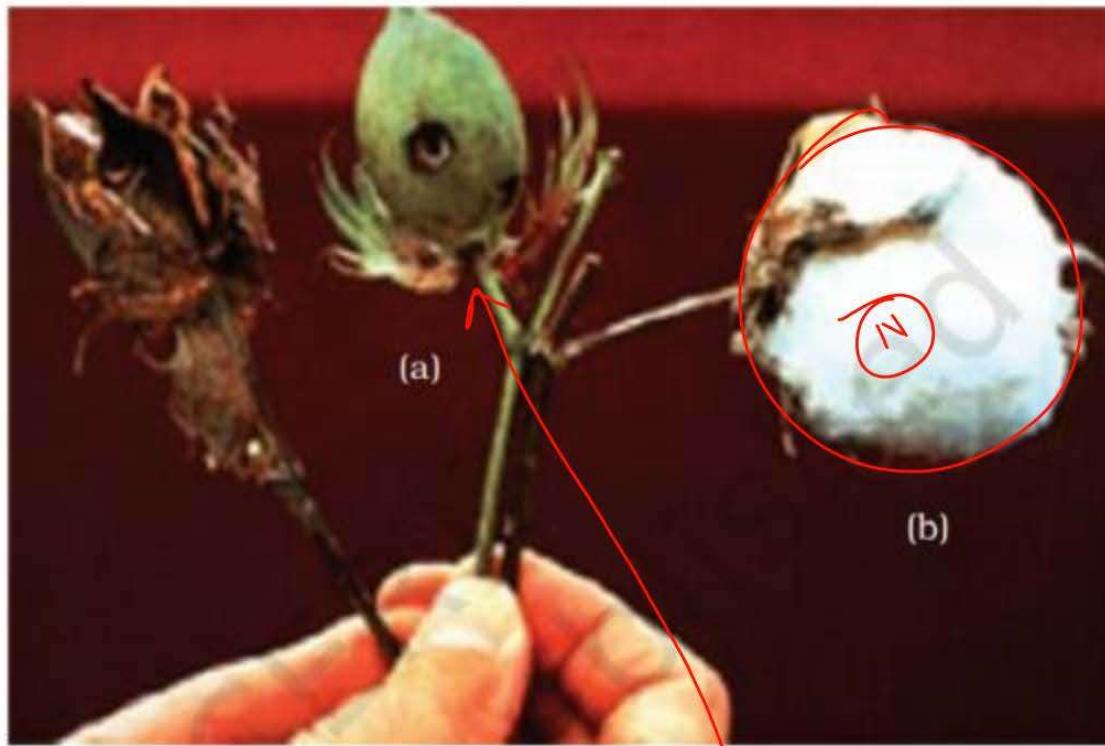
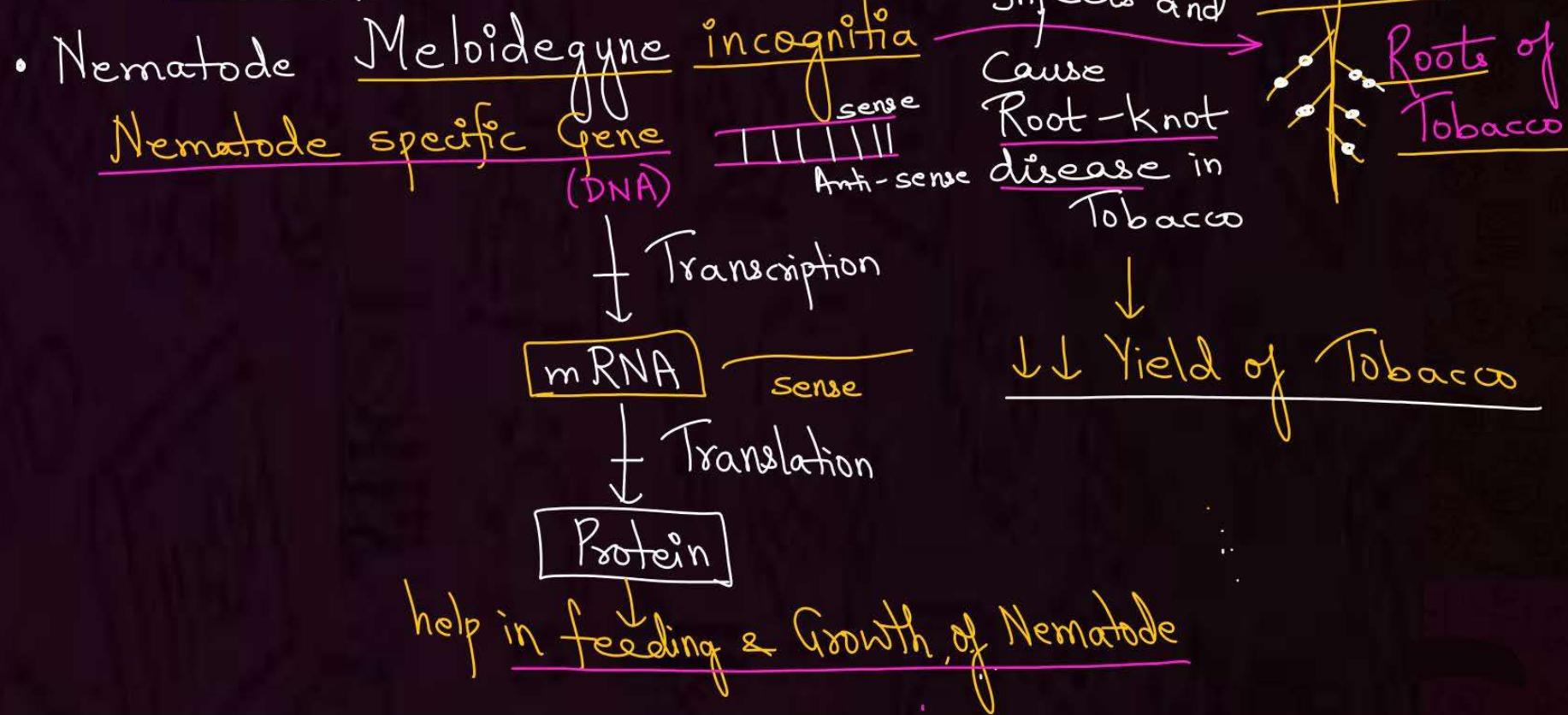


Figure 10.1 Cotton boll: (a) destroyed by bollworms; (b) a fully mature cotton boll

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* Pest-resistant Tobacco by RNA interference
Nematode-resistant
(Roundworm)



* RNA interference / RNAi / mRNA silencing /
Anti-sense RNA technology :-

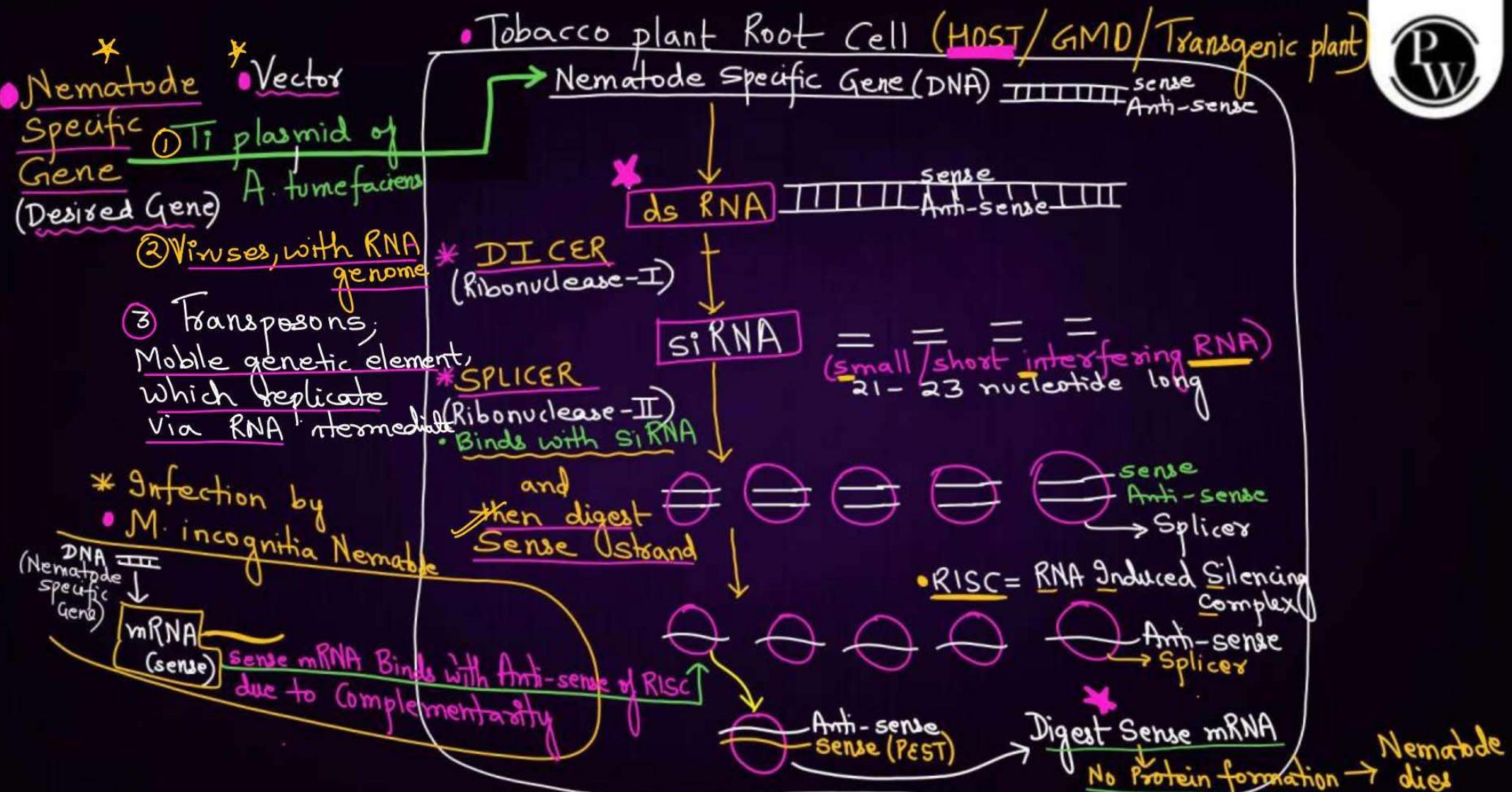
present in All Eukaryotes as "Natural Cellular Defence Mechanism"
(Protist, Fungi, Plant, Animal)



Stop Expression of Nematode-specific gene

OR

Stop Translation of mRNA into Protein
By forming dsRNA



Pest Resistant Plants: Several nematodes parasitise a wide variety of plants and animals including human beings. A nematode *Meloidegyne incognita* infects the roots of tobacco plants and causes a great reduction in yield. A novel strategy was adopted to prevent this infestation which was based on the process of **RNA interference** (RNAi). RNAi takes place in all eukaryotic organisms as a method of cellular defense. This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing). The source of this complementary RNA could be from an infection by viruses ^① having RNA genomes or mobile genetic elements (transposons) ^② that replicate via an RNA intermediate.

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Using *Agrobacterium* vectors, ⁽³⁾ nematode-specific genes were introduced into the host plant (Figure 10.2). The introduction of DNA was such that it produced both sense and anti-sense RNA in the host cells. These two RNA's being complementary to each other formed a double stranded (dsRNA) that initiated RNAi and thus, silenced the specific mRNA of the nematode. The consequence was that the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plant therefore got itself protected from the parasite (Figure 10.2).

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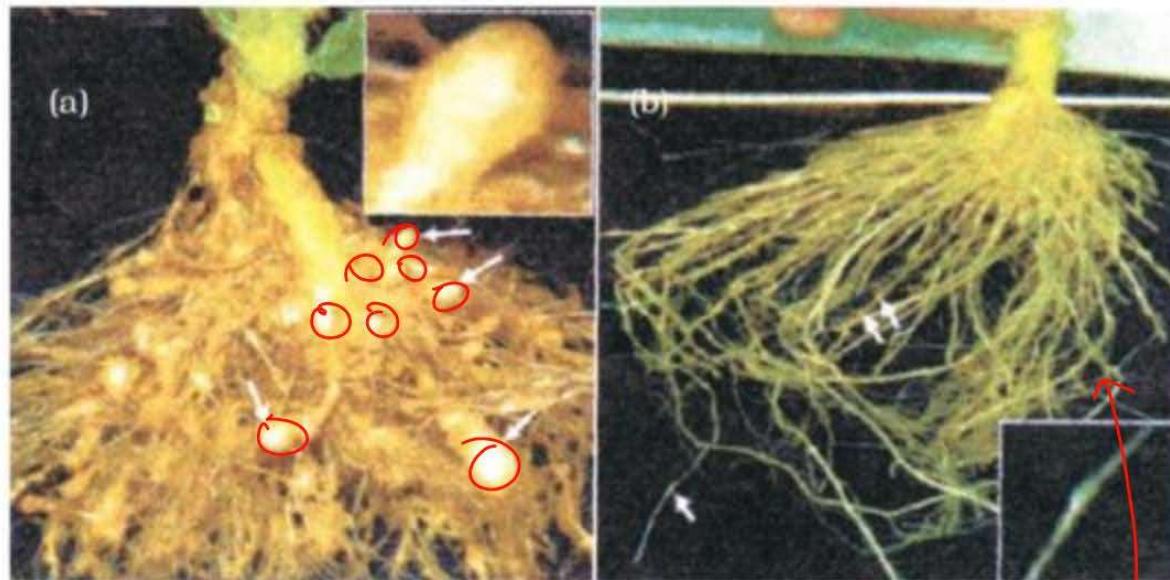


Figure 10.2 Host plant-generated dsRNA triggers protection against nematode infestation:
(a) Roots of a typical control plants; (b) transgenic plant roots 5 days after deliberate infection of nematode but protected through novel mechanism.

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10.2 BIOTECHNOLOGICAL APPLICATIONS IN MEDICINE

The recombinant DNA technological processes have made immense impact in the area of healthcare by enabling mass production of safe and more effective therapeutic drugs. Further, the recombinant therapeutics do not induce unwanted immunological responses as is common in case of similar products isolated from non-human sources. At present, about 30 recombinant therapeutics have been approved for human-use the world over. In India, 12 of these are presently being marketed.

10.2.1 Genetically Engineered Insulin

Management of adult-onset diabetes is possible by taking insulin at regular time intervals. *What would a diabetic patient do if enough human-insulin was not available?* If you discuss this, you would soon realise

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that one would have to isolate and use insulin from other animals. Would the insulin isolated from other animals be just as effective as that secreted by the human body itself and would it not elicit an immune response in the human body? Now, imagine if bacterium were available that could make human insulin. Suddenly the whole process becomes so simple. You can easily grow a large quantity of the bacteria and make as much insulin as you need.

→ Polypeptide hormone (51 amino-acids)

Think about whether insulin can be orally administered to diabetic people or not. Why? NO, as it will degraded in alimentary canal

Insulin used for diabetes was earlier extracted from pancreas of slaughtered cattle and pigs. Insulin from an animal source, though caused some patients to develop allergy or other types of reactions to the foreign protein. Insulin consists of two short polypeptide chains: chain A and chain B, that are linked together by disulphide bridges (Figure 10.3).

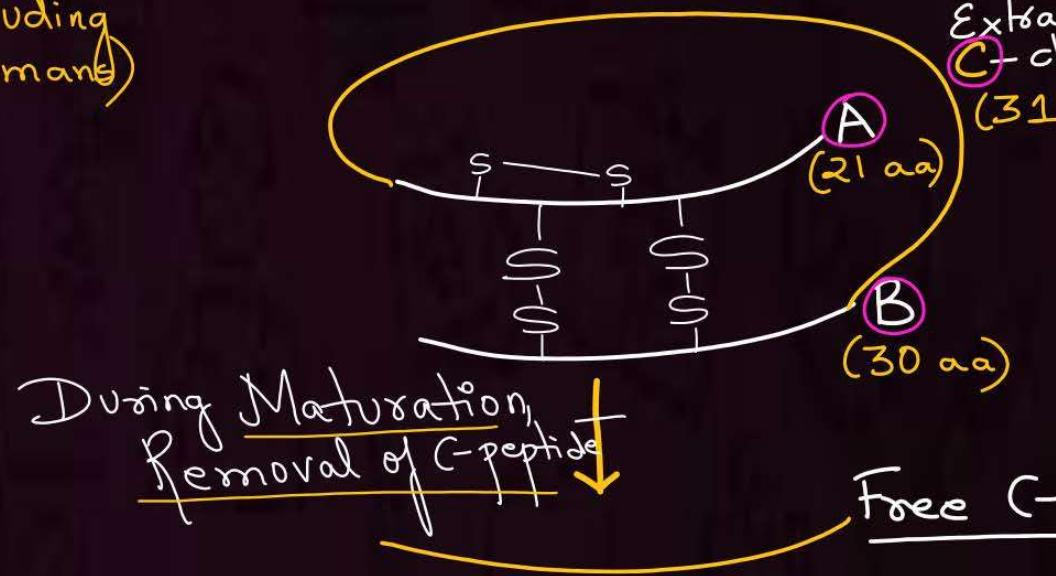
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* Insulin Gene → β -cells of Pancreas → PRO-INSULIN (inactive)

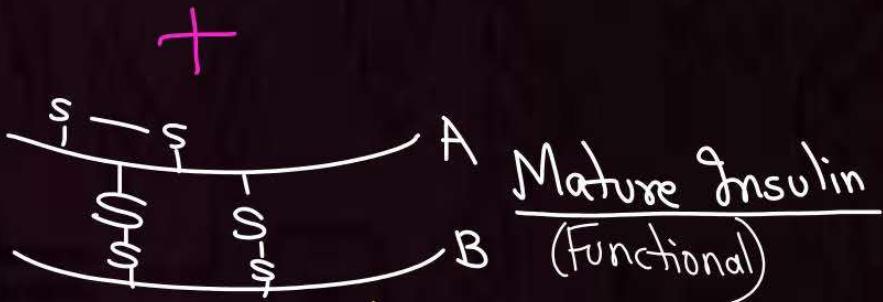
(Mammals, including humans)

Extra-stretch Peptide
C-chain, links A & B chains

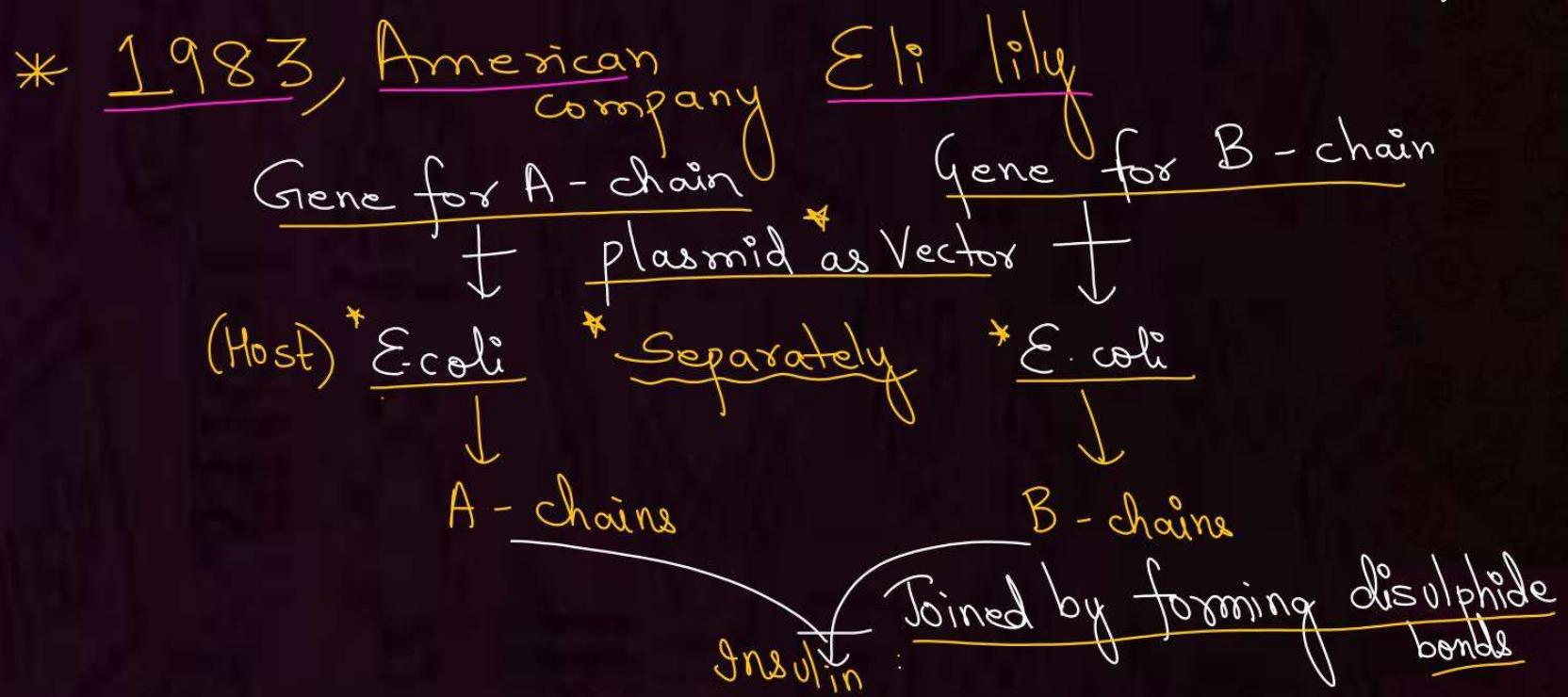


During Maturation,
Removal of C-peptide

Free C-peptide



- * Biggest challenge in producing GE Insulin was getting Insulin assembled during mature form 1st GE drug/Hormone



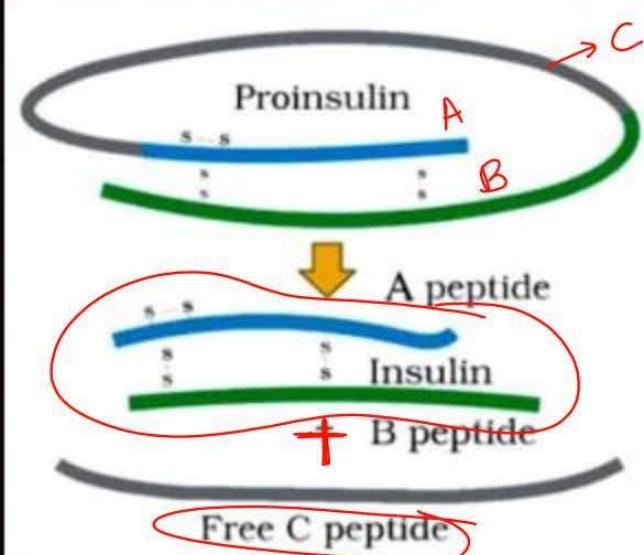


Figure 10.3 Maturation of pro-insulin into insulin (simplified)

In mammals, including humans, insulin is synthesised as a pro-hormone (like a pro-enzyme, the pro-hormone also needs to be processed before it becomes a fully mature and functional hormone) which contains an extra stretch called the **C peptide**. This C peptide is not present in the mature insulin and is removed during maturation into insulin. The main challenge for production of insulin using rDNA techniques was getting insulin assembled into a mature form. In 1983 Eli Lilly an American company prepared two DNA sequences corresponding to A and B, chains of human insulin and introduced them in plasmids of *E. coli* to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulfide bonds to form human insulin.

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10.2.2 Gene Therapy

If a person is born with a hereditary disease, can a corrective therapy be taken for such a disease? Gene therapy is an attempt to do this. Gene therapy is a collection of methods that allows correction of a gene defect that has been diagnosed in a child/embryo. Here genes are inserted into a person's cells and tissues to treat a disease. Correction of a genetic defect involves delivery of a normal gene into the individual or embryo to take over the function of and compensate for the non-functional gene.

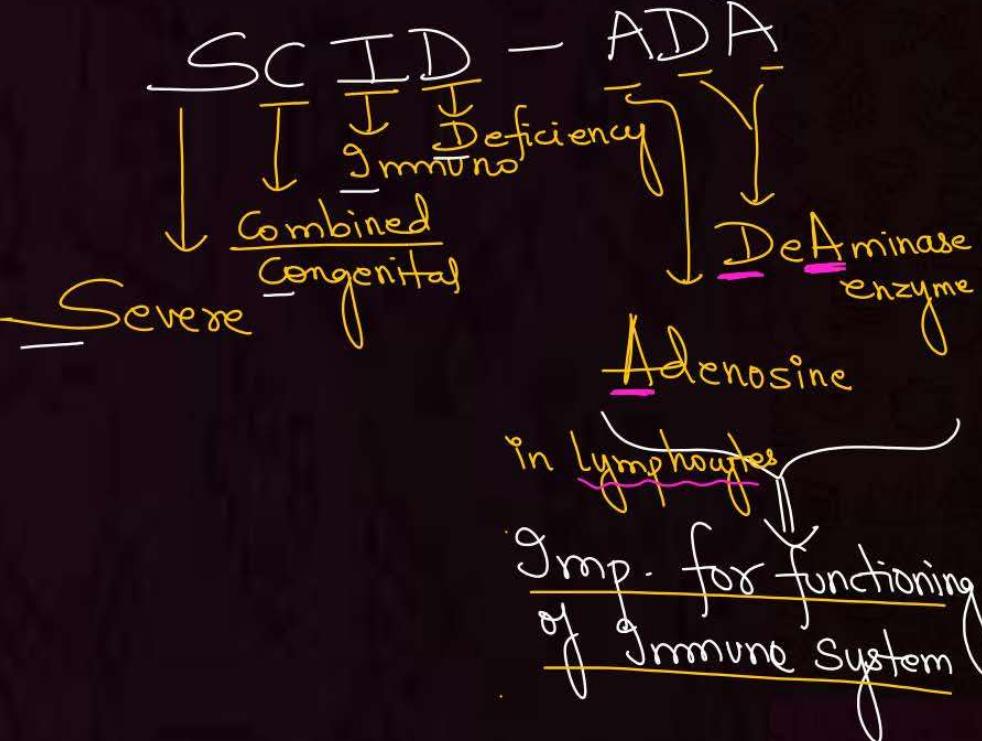
The first clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency. This enzyme is crucial for the immune system to function. The disorder is caused due to the deletion of the gene for adenosine deaminase. In some children ADA deficiency can be cured by bone marrow transplantation; in others it can be treated

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*

Gene therapy :- 1ST time;

4 yrs Girl in 1990
suffering from



* Treatment :-

- Both Not Completely Curable
- 1. Enzyme Replacement Therapy :- functional ADA Enzyme by injection
 - 2. Bone Marrow Transplantation (BM is origin of all cells)
 - 3. Gene therapy : Periodic infusions of GE Lymphocytes

• Permanent Cure for SCID-ADA

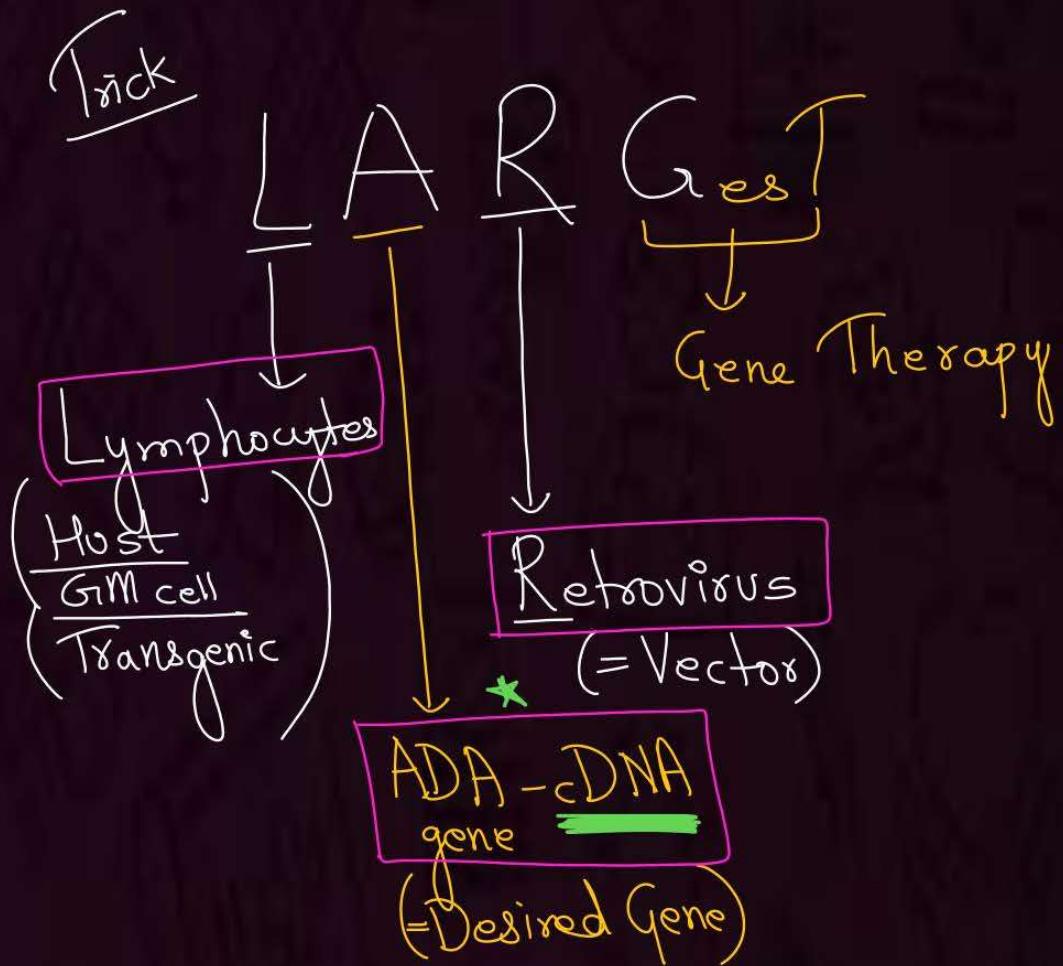
As Lymphocytes are Not Immortal
if G-therapy given at Early Embryonic Stage (totipotent Stem cells)

* Lymphocytes taken out from patient's blood
(defective ADA gene)

Lymphocytes Culture outside body

Introduce * Functional ADA - cDNA into * lymphocytes, using
* Retrovirus as vector
(RNA - Genetic material)

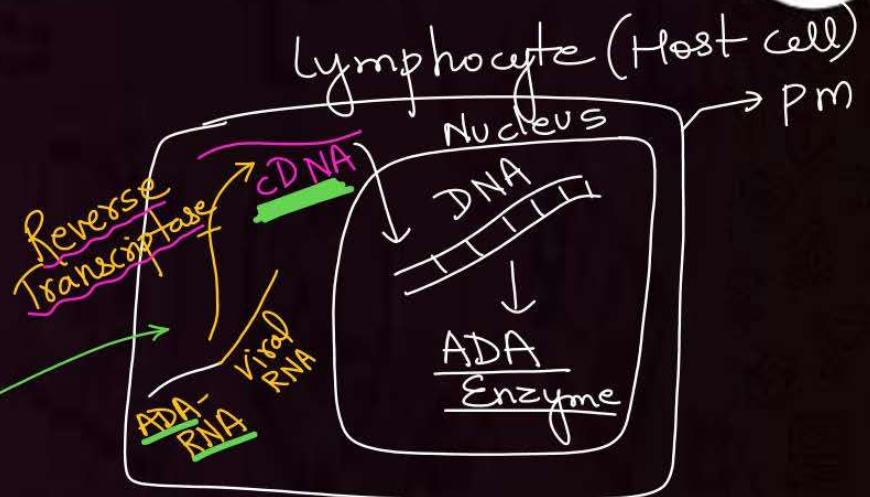
Genetically Engineered lymphocytes returned back into
patient's blood



ADA gene (ds DNA)

↓ Transcription (in lab)

ADA - RNA (ss)



disarmed Retrovirus (as Vector)
modified

* Viral RNA → cDNA
Reverse Transcription (complementary DNA)

by enzyme replacement therapy, in which functional ADA is given to the patient by injection. But the problem with both of these approaches is that they are not completely curative. As a first step towards gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body. A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are subsequently returned to the patient. However, as these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes. However, if the gene isolate from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.

10.2.3 Molecular Diagnosis

You know that for effective treatment of a disease, early diagnosis and understanding its pathophysiology is very important. Using conventional methods of diagnosis (serum and urine analysis, etc.) early detection is

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not possible. Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme Linked Immuno-sorbent Assay (ELISA) are some of the techniques that serve the purpose of early diagnosis.

Presence of a pathogen (bacteria, viruses, etc.) is normally suspected only when the pathogen has produced a disease symptom. By this time the concentration of pathogen is already very high in the body. However, very low concentration of a bacteria or virus (at a time when the symptoms of the disease are not yet visible) can be detected by amplification of their nucleic acid by PCR. Can you explain how PCR can detect very low amounts of DNA? PCR is now routinely used to detect HIV in suspected AIDS patients. It is being used to detect mutations in genes in suspected cancer patients too. It is a powerful technique to identify many other genetic disorders.

A single stranded DNA or RNA, tagged with a radioactive molecule (probe) is allowed to hybridise to its complementary DNA in a clone of cells followed by detection using autoradiography. The clone having the

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* AUTO-RADIOGRAPHY :- (X-rays)

PROBE =

Single-stranded DNA/RNA,
complementary to gene (Normal)
tagged with Radioactive material

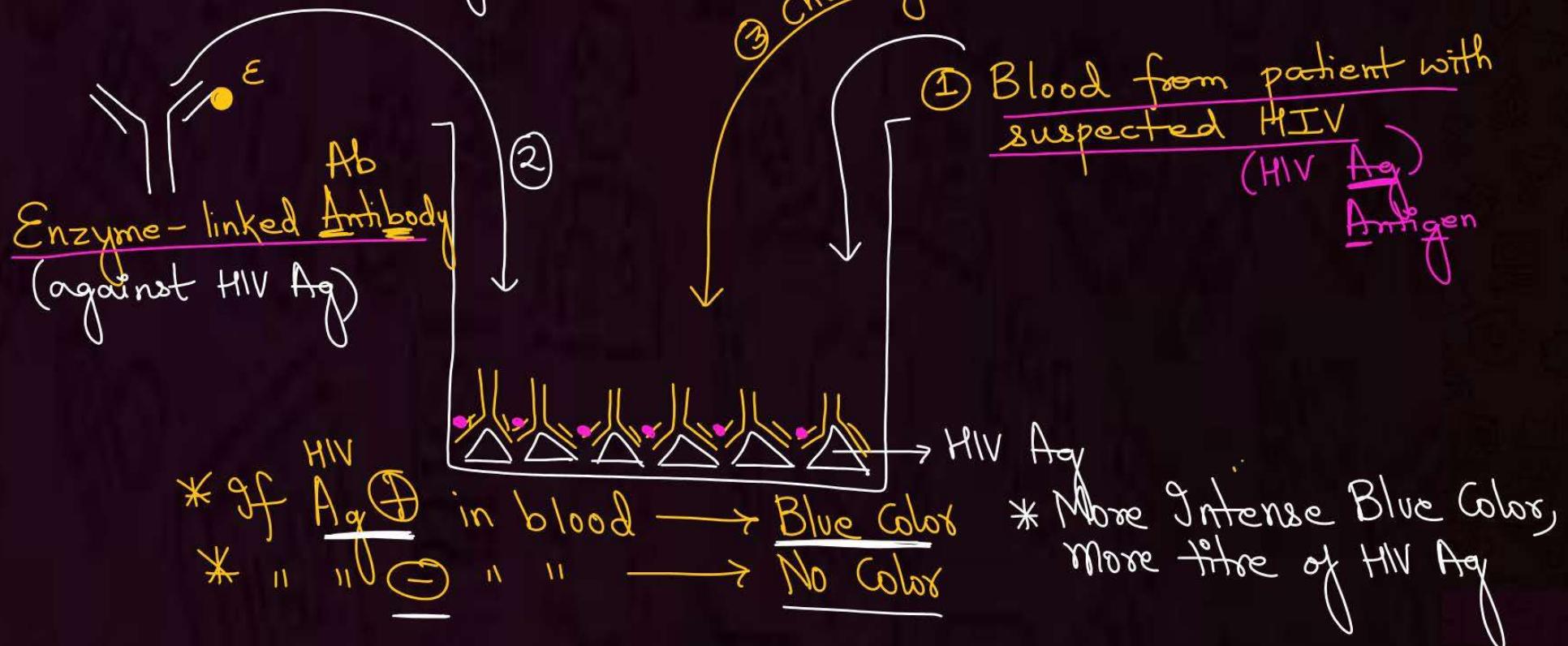


II Mutated Gene AR \Rightarrow Do not appear on film (X-rays) because no complementarity with probe

I Normal Gene \Rightarrow Appear on Photographic film (X-rays) due to complementarity



* ELISA = Enzyme Linked ImmunoSorbent Assay
 Screening Test for AIDS



- Principle :- Ag - Ab Interaction

- Diagnosis made by detecting Antigen or Antibody, synthesised ^{against} Antigen
-
- The diagram illustrates a laboratory assay for antigen-antibody interaction. It shows a test tube containing a mixture of patient blood (Pt. blood) and a labeled antigen (Ag(lab)). A portion of this mixture is removed and added to a well containing a chromogenic substrate. The reaction is catalyzed by an enzyme (E). The resulting color change is measured at four different time points (labeled 1, 2, 3, and 4), with the final result being compared to a control curve.

mutated gene will hence not appear on the photographic film, because the probe will not have complementarity with the mutated gene.

ELISA is based on the principle of antigen-antibody interaction. Infection by pathogen can be detected by the presence of antigens (proteins, glycoproteins, etc.) or by detecting the antibodies synthesised against the pathogen.

10.3 TRANSGENIC ANIMALS

Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are known as **transgenic animals**. Transgenic rats, rabbits, pigs, sheep, cows and fish have been produced, although over 95 per cent of all existing transgenic animals are mice. *Why are these animals being produced? How can man benefit from such modifications?* Let us try and explore some of the common reasons:

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- (i) **Normal physiology and development:** Transgenic animals can be specifically designed to allow the study of how genes are regulated, and how they affect the normal functions of the body and its development, e.g., study of complex factors involved in growth such as insulin-like growth factor. By introducing genes from other species that alter the formation of this factor and studying the biological effects that result, information is obtained about the biological role of the factor in the body.
- (ii) **Study of disease:** Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.

→ RCAR

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(iii) **Biological products:** Medicines required to treat certain human diseases can contain biological products, but such products are often expensive to make. Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein (α -1-antitrypsin) used to treat emphysema. Similar attempts are being made for treatment of phenylketonuria (PKU) and cystic fibrosis. In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk (2.4 grams per litre). The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk.

(iv) **Vaccine safety:** Transgenic mice are being developed for use in testing the safety of vaccines before they are used on humans. Transgenic mice are being used to test the safety of the polio vaccine. If successful and found to be reliable, they could replace the use of monkeys to test the safety of batches of the vaccine.



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(v) **Chemical safety testing:** This is known as toxicity/safety testing. The procedure is the same as that used for testing toxicity of drugs. Transgenic animals are made that carry genes which make them more sensitive to toxic substances than non-transgenic animals. They are then exposed to the toxic substances and the effects studied. Toxicity testing in such animals will allow us to obtain results in less time.

10.4 ETHICAL ISSUES

The manipulation of living organisms by the human race cannot go on any further, without regulation. Some ethical standards are required to evaluate the morality of all human activities that might help or harm living organisms.

Going beyond the morality of such issues, the biological significance of such things is also important. Genetic modification of organisms can have unpredictable results when such organisms are introduced into the ecosystem.

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Therefore, the Indian Government has set up organisations such as **GEAC** (Genetic Engineering Approval Committee), which will make decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services.

The modification/usage of living organisms for public services (as food and medicine sources, for example) has also created problems with patents granted for the same.

There is growing public anger that certain companies are being granted patents for products and technologies that make use of the genetic materials, plants and other biological resources that have long been identified, developed and used by farmers and indigenous people of a specific region/country.

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Rice is an important food grain, the presence of which goes back thousands of years in Asia's agricultural history. There are an estimated 200,000 varieties of rice in India alone.^{2 b.c} The diversity of rice in India is one of the richest in the world. Basmati rice is distinct for its unique aroma and flavour and 27 documented varieties of Basmati are grown in India. There is reference to Basmati in ancient texts, folklore and poetry, as it has been grown for centuries. In 1997, an American company got patent rights on Basmati rice through the US Patent and Trademark Office. This allowed the company to sell a 'new' variety of Basmati, in the US and abroad. This 'new' variety of Basmati had actually been derived from Indian farmer's varieties. Indian Basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty. The patent extends to functional equivalents, implying that

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other people selling Basmati rice could be restricted by the patent. Several attempts have also been made to patent uses, products and processes based on Indian traditional herbal medicines, e.g., turmeric, neem. If we are not vigilant and we do not immediately counter these patent applications, other countries/individuals may encash on our rich legacy and we may not be able to do anything about it.

Biopiracy is the term used to refer to the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.

Most of the industrialised nations are rich financially but poor in biodiversity and traditional knowledge. In contrast the developing and the underdeveloped world is rich in biodiversity and traditional knowledge related to bio-resources. Traditional knowledge related to

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bio-resources can be exploited to develop modern applications and can also be used to save time, effort and expenditure during their commercialisation.

There has been growing realisation of the injustice, inadequate compensation and benefit sharing between developed and developing countries. Therefore, some nations are developing laws to prevent such unauthorised exploitation of their bio-resources and traditional knowledge.

The Indian Parliament has recently cleared the second amendment of the Indian Patents Bill, that takes such issues into consideration, including patent terms emergency provisions and research and development initiative.

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QUESTION - 01 (2022)

Transposons can be used during which one of the following?

- A Gene sequencing
- B Polymerase Chain Reaction
- C Gene silencing
- D Autoradiography

Tobacco
RNA?

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QUESTION - 02 (2020)

Bt cotton variety that was developed by the introduction of toxin gene of *Bacillus thuringiensis* (Bt) is resistant to

- A** Fungal diseases ✗
- B** Plant nematodes ✗
- C** Insect predators ✗
- D** Insect pests ↗

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QUESTION - 03 (2020-Covid)



RNA interference is used for which of the following purposes in the field of biotechnology?

- A To develop a pest resistant plant against infestation by nematode
- B To enhance the mineral usage by the plant
- C To reduce post harvest losses
- D To develop a plant tolerant to abiotic stresses

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QUESTION - 04 (2019)

Which of the following is true for **Golden rice?**

- A** It is Vitamin A enriched, with a gene from daffodil *NICERT*
- B** It is pest resistant, with a gene from *Bacillus thuringiensis*
- C** It is drought tolerant, developed using *Agrobacterium* vector
- D** It has yellow grains, because of a gene introduced from a primitive variety of rice *Out of NICERT*

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QUESTION - 05 (2019)



What triggers activation of protoxin to active Bt toxin of *Bacillus thuringiensis* in boll worm?

A Body temperature

B Moist surface of midgut

C Alkaline pH of gut

D Acidic pH of stomach

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QUESTION - 06 (2016-I)



Which part of the tobacco plant is infected by Meloidogyne incognita?

- A** Flower
- B** Leaf
- C** Stem
- D** Root

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QUESTION - 07 (2015)



In Bt cotton, the Bt toxin present in plant tissue as pro-toxin is converted into active toxin due to:

- A Action of gut micro-organism
- B Presence of conversion factors in insect gut
- C Alkaline pH of the insect gut
- D Acidic pH of the insect gut

Repetet

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QUESTION - 08 (2015 Re)



Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of:

- A Vitamin C
- B Omega 3
- C Vitamin A
- D Vitamin B

Repeat

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QUESTION - 09 (2013)



Which of the following Bt crops is being grown in India by the farmers?

- A** Soyabean
- B** Maize
- C** cotton
- D** Brinjal

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QUESTION - 10 (2022)



In gene therapy of Adenosine Deaminase (ADA) deficiency, the patient requires periodic infusion genetically engineered lymphocytes because:

- A Genetically engineered lymphocytes are not immortal cells.
- B Retroviral vector is introduced into these lymphocytes.
- C Gene isolated from marrow cells producing ADA is introduced into cells at embryonic stages
- D Lymphocytes from patient's blood are grown in culture, outside the body.

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QUESTION - 11 (2022)



Add in
Notes

Statements related to human Insulin are given below. Which statement(s) is/are correct about genetically engineered Insulin?

- A. Pro-hormone insulin contain extra stretch of C-peptide
- B. A-peptide and B-peptide chains of insulin were produced separately in E.coli, extracted and combined by creating disulphide bond between them.
- C. Insulin used for treating Diabetes was extracted from Cattles and Pigs.
- D. Pro-hormone Insulin needs to be processed for converting into a mature and functional hormone.
- E. Some patients develop allergic reactions to the foreign insulin.

Choose the most appropriate answer from the options given below.

A C, D and E only

C B only

B A, B and D only

D C and D only

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 12 (2021)



When gene targeting involving gene amplification is attempted in an individual's tissue to treat disease, it is known as:

A Gene therapy

B Molecular diagnosis

C Safety testing

D Biopiracy

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 13 (2021)



Which of the following is not an application of PCR (Polymerase Chain Reaction) ?

A Gene amplification

B Purification of isolated protein

C Detection of gene mutation

D Molecular diagnosis

Down to:

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 14 (2021)



Which of the following is a correct sequence of steps in a PCR (Polymerase Chain Reaction)?

- A Denaturation, Extension, Annealing
- B Extension, Denaturation, Annealing
- C Annealing, Denaturation, Extension
- D Denaturation, Annealing, Extension

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 15 (2021)



Now a days it is possible to detect the mutated gene causing cancer by allowing radioactive probe to hybridise its complimentary DNA in a clone of cells, followed by its detection using autoradiography because:

- A Mutated gene completely and clearly appears on a photographic film. X
- B Mutated gene does not appear on a photographic film as the prober has no complimentarity with it. X
- C Mutated gene does not appear on photographic film as the probe has complimentarity with it. X
- D Mutated gene partially appears on a photographic film. X

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 16 (2021)



With regard to insulin choose correct options.

- A. C-peptide is not present in mature insulin. ✓
- B. The insulin produced by rDNA technology has C-peptide. ✗
- C. The pro-insulin has C-peptide. ✓
- D. A-peptide and B-peptide of insulin are interconnected by disulphide bridges. ✓

Choose the correct answer from the options given below.

- A** B and C only ✗
- B** A, C and D only ✓
- C** A and D only
- D** B and D only ✗

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 17 (2021)



For effective treatment of the disease, early diagnosis and understanding its pathophysiology is very important. Which of the following molecular diagnostic techniques is very useful for early detection?

A Southern Blotting Technique X

B ELISA Technique ~~X~~

C Hybridization Technique ~~X~~

D Western Blotting Technique ~~X~~

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 18 (2021)



The **adenosine deaminase deficiency** results into:

- A** Parkinson's disease X
- B** Digestive disorder X
- C** Addison's disease X
- D** Dysfunction of Immune system ~~X~~

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 19 (2020)

Which of the following statements is not correct?

False ✓

- A The proinsulin has an extra peptide called C-peptide
- B The functional insulin has A and B chains linked together by hydrogen bonds ~~✓~~ disulf
- C Genetically engineered insulin is produced in E.coli.
- D In man insulin is synthesised as a proinsulin. ✓

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 20 (2020)

Match the following columns and select the correct option

A A-(II), B-(II), C-(I), D-(IV)

B A-(II), B-(III), C-(IV), D-(I)

C A-(I), B-(II), C-(III), D-(IV)

D A-(IV), B-(I), C-(II), D-(III)

	Column-I		Column-II
(A)	Bt cotton	(I)	Gene therapy
(B)	Adenosine deaminase deficiency	(II)	Cellular defence
(C)	RNAi	(III)	Detection of HIV infection
(D)	PCR	(IV)	<i>Bacillus thuringiensis</i>

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 21 (2018)



Which of the following is commonly used as a vector for introducing a DNA fragment in human lymphocytes?

- A Retrovirus
- B Ti plasmid
- C λ phage
- D pBR322

(Host
Animal)

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 22 (2016 II)



Which kind of therapy was given in 1990 to a four year old girl with adenosine deaminase (ADA) deficiency?

- A Immunotherapy
- B Radiation therapy
- C Gene therapy
- D Chemotherapy

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 23 (2016-I)



The two polypeptides of human insulin are linked together by:

- A** Hydrogen bonds
- B** Phosphodiester bond
- C** Covalent bond
- D** Disulphide bridges

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 24 (2014)



ADA is an enzyme which is deficient in a genetic disorder SCID. What is the full form of ADA?

- A Adenosine DeoxyAminase
- B Adenosine Deaminase
- C Aspartate Deaminase
- D Arginine Deaminase

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 25 (2014)



The first human hormone produced by recombinant DNA technology is:

- A** Progesterone
- B** ~~Insulin~~
- C** Estrogen
- D** Thyroxin

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 26 (2020-Covid)



Add in Notes

The laws and rules to prevent unauthorised exploitation of bio-resources are termed as-

A Bioethics

B Bioengineering

C Biopiracy

D Biopatenting

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 27 (2018)



In India, the organisation responsible for assessing the safety of introducing genetically modified organisms for public use is:

- A Indian Council of Medical Research (ICMR)
- B Council for Scientific and Industrial Research (CSIR)
- C Research Committee on Genetic Manipulation (RCGM)
- D Genetic Engineering Appraisal Committee (GEAC)
Approval

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 28 (2018)



A 'new' variety of rice was patented by a foreign company though such varieties have been present in India for a long time. This is related to:

A Co-667

B Sharbati Sonora

C Lerma Rojo

D Basmati

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 29 (2018)



Use of bioresources by multinational companies and organisations without authorisation from the concerned country and its people is called:

- A Bio-infringement
- B Biopiracy
- C Biodegradation
- D Bioexploitation

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 30 (2015)



Which body of the Government of India regulates GM research and safety of introducing GM organisms for public services?

A Genetic Engineering Approval Committee

B Research Committee on Genetic Manipulation

C Bio-safety committee

D Indian Council of Agricultural Research

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 31 (2023)



Which one of the following techniques **does not serve the purpose of early diagnosis of a disease for its early treatment?**

- A Enzyme Linked Immuno-Sorbent Assay (ELISA) technique ✓
- B Recombinant DNA Technology ✓
- C Serum and Urine analysis ✓
- D Polymerase Chain Reaction (PCR) technique ✓

False

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 32 (NEET 2024)**Match List I with List II:****Choose the correct answer from the options given below:****A**

A-III, B-IV, C-I, D-II

B

A-II, B-IV, C-I, D-III

C

A-II, B-I, C-IV, D-III

D

A-III, B-I, C-II, D-IV

	List I		List II
A.	a-1 antitrypsin	I.	Cotton bollworm
B.	Cry IAb	II.	ADA deficiency
C.	Cry IAc	III.	Emphysema
D.	Enzyme replacement therapy	IV.	Corn borer

FOR NOTES & DPP CHECK DESCRIPTION

QUESTION - 33 (NEET 2024)

Given below are two statements:

Statement I: Bt toxins are insect group specific and coded by a gene cry lac.

Statement II: Bt toxin exists as inactive protoxin in B. thuringiensis. However, after ingestion by the insect the inactive protoxin gets converted into active form due to acidic pH of the insect gut.

In the light of the above statements, choose the correct answer from the options given below

~~alkaline~~ A Statement I is true but Statement II is false

B Statement I is false but Statement II is true

C Both Statement I and Statement II are true

D Both Statement I and Statement II are false

FOR NOTES & DPP CHECK DESCRIPTION



Homework



Read NCERT
thoroughly

FOR NOTES & DPP CHECK DESCRIPTION
