

Gene Therapy (I)

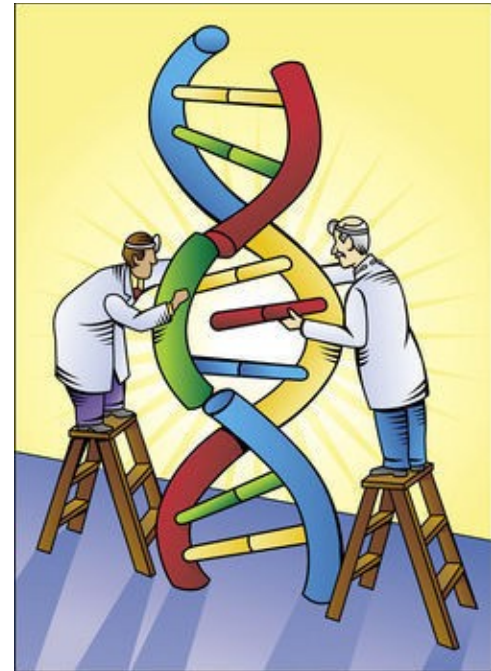
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Objectives of this lecture

By the end of this lecture you will be able to:

1. Define the term “Gene Therapy”
2. Use the correct terminology for gene transfer
3. Realize the significance of gene therapy research

What is gene therapy?



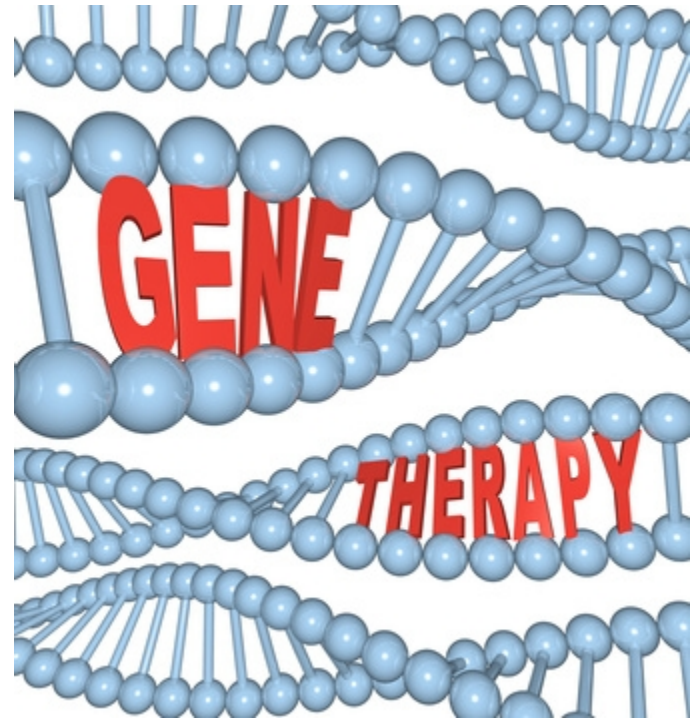
What is gene therapy?

Introduction of **new genetic material** into a **cell** for **therapeutic purposes**

Genetic Materials:

DNA

RNA



Problem	Example	Solution
Defect in protein expression	G6PD deficiency	Introduce a correct version of the gene
Expression of harmful proteins	Cancer	Inhibit or block the harmful proteins

Advantages of gene therapy

- **Specificity**
- **Can be either temporary or permanent**
- **Localization**
- **Low immunogenicity**

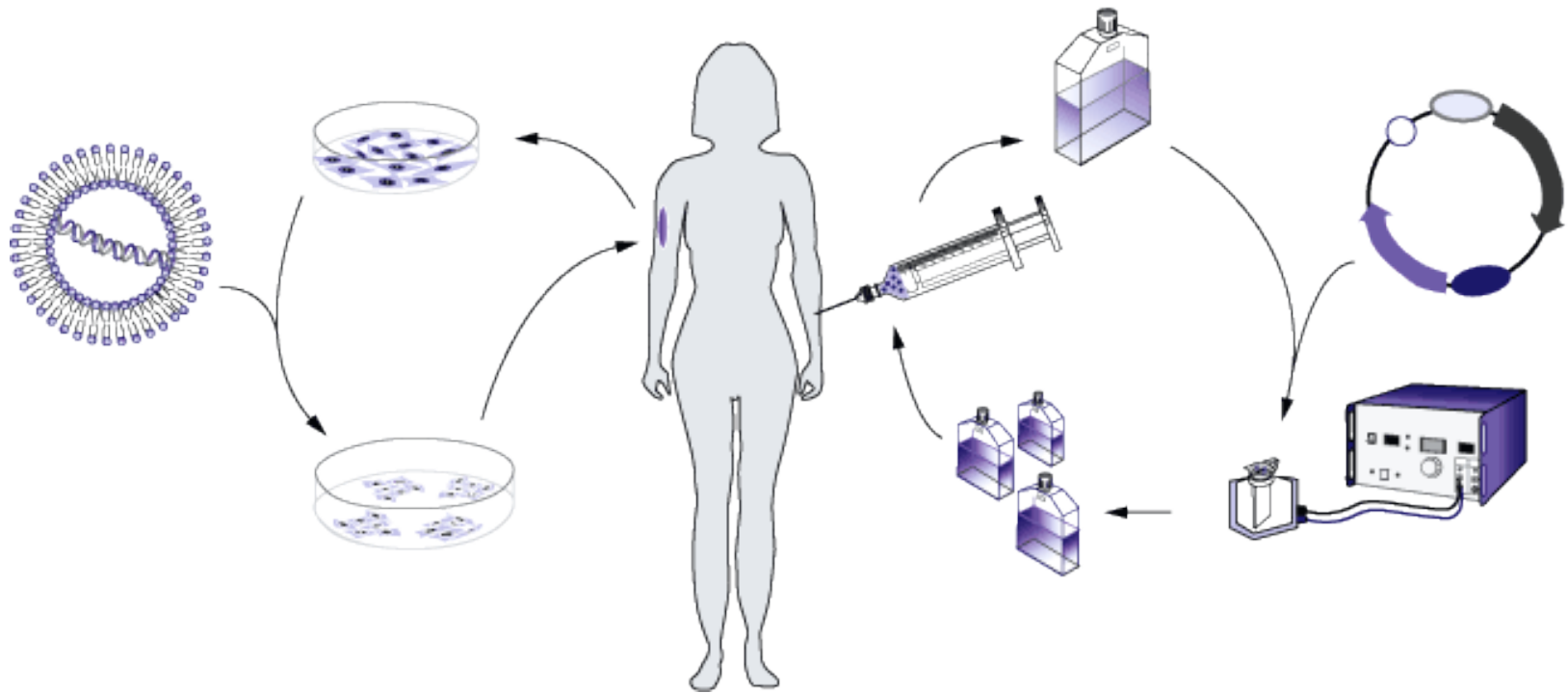
Gene Therapy

- **Germ-Line Gene Therapy:**
 - Introduction of genes into germ cells (sperm and ovum)
- **Somatic Gene Therapy:**
 - Introduction of genes into somatic cells

Germ-Line Gene Therapy

- **Hypothetically, germ-line therapy prevents transfer of defective genes to subsequent generation**
- **Due to ethical and safety reasons, it is not presently accepted for human application**
- **However, it is used for the transgenic laboratory animals production**

Ex Vivo Gene Therapy



Advantage

Specificity

High transfection efficiency

Disadvantage

Time and labor consuming

Invasive

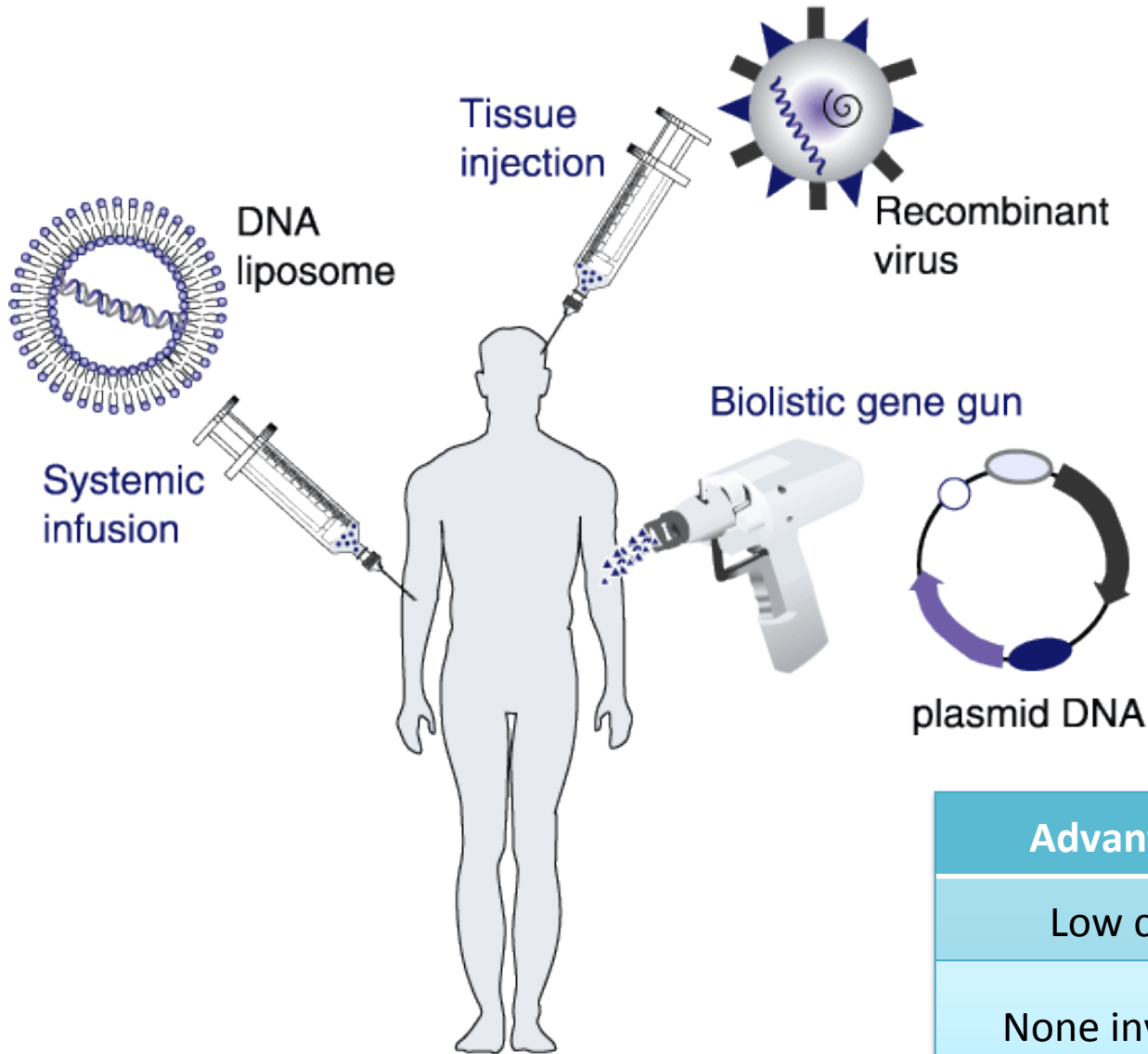
Contamination

Not every cell type is growable

Ex vivo gene therapy

- **Most widely used in clinical trials**
- **Some attempts in practice**

In Vivo Gene Therapy



Advantage	Disadvantage
Low cost	None specificity
None invasive	Low transfection efficiency
Less contamination	

In vivo gene therapy

- **Some organs are less suited for *ex vivo* e.g. (brain, heart and lungs)**
- **More practical approach**

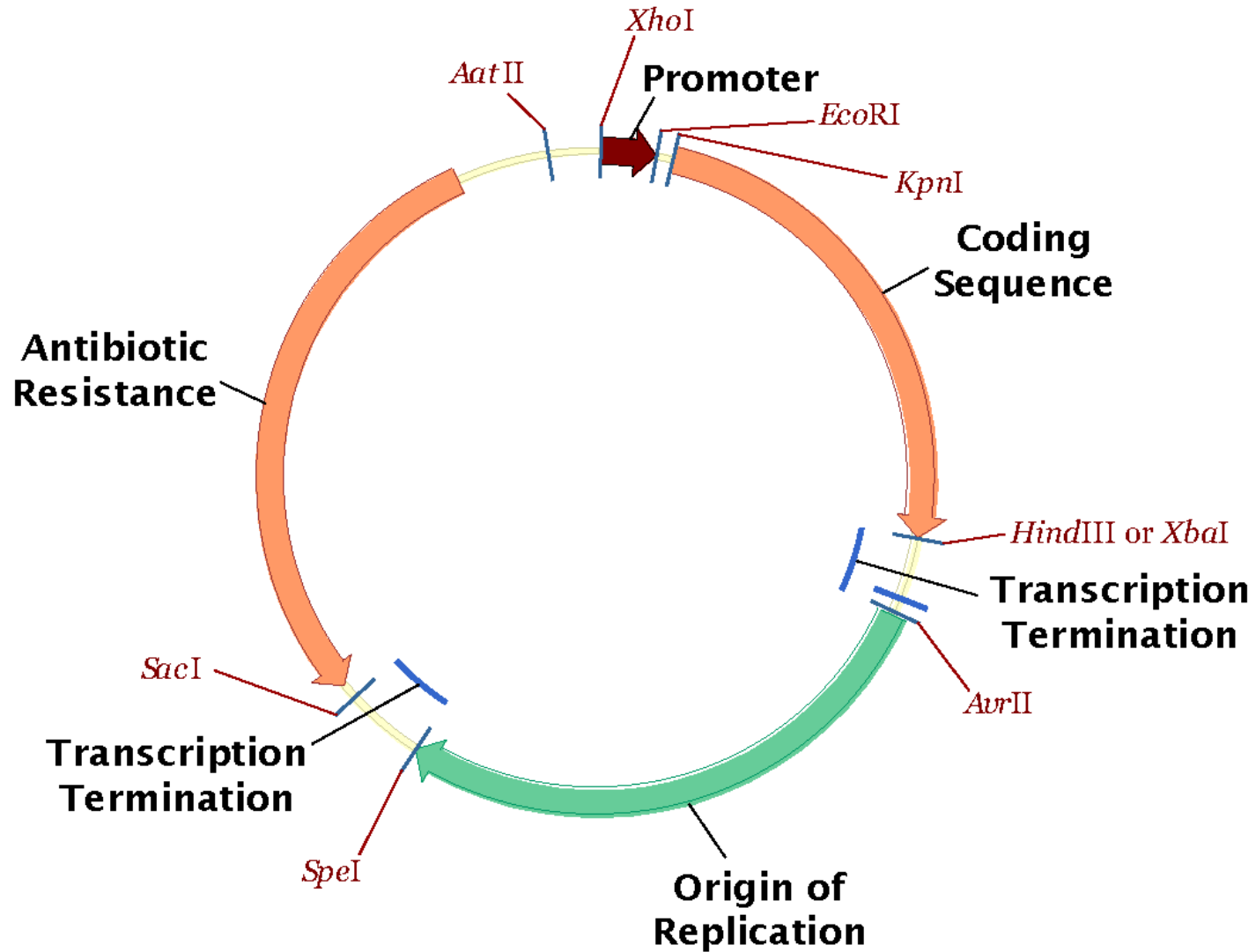
Gene Therapy Considerations

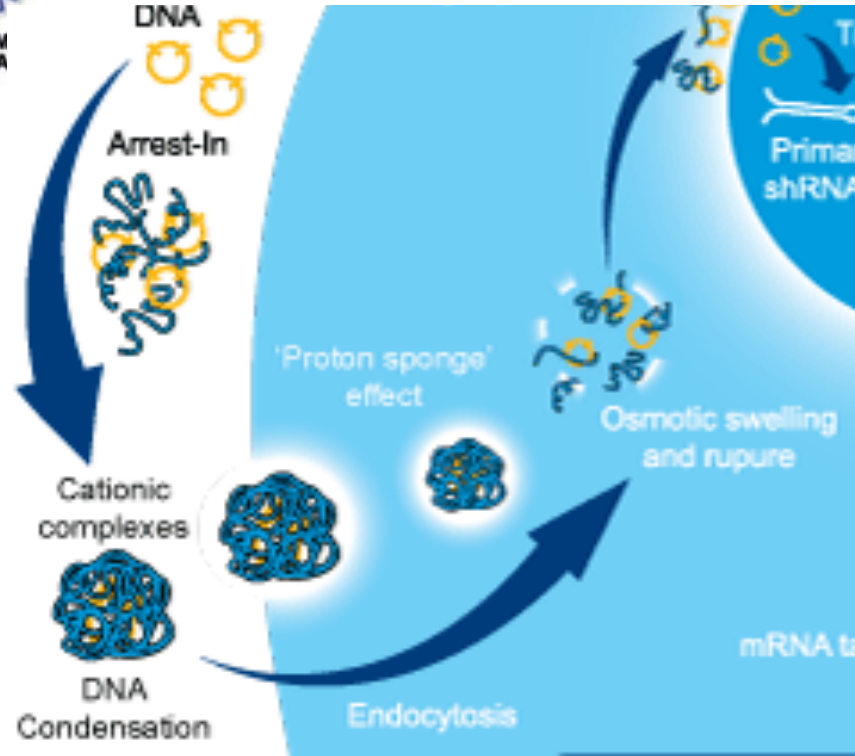
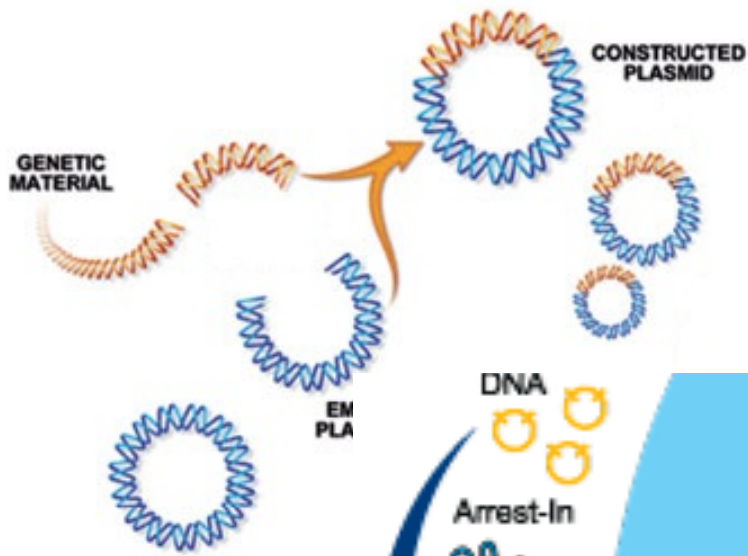
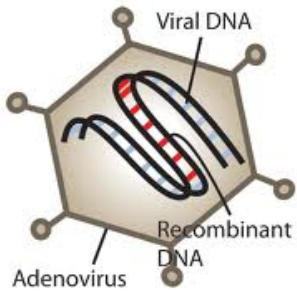
- What gene will be delivered or targeted?
- What method will be used?

Elements for gene transfer

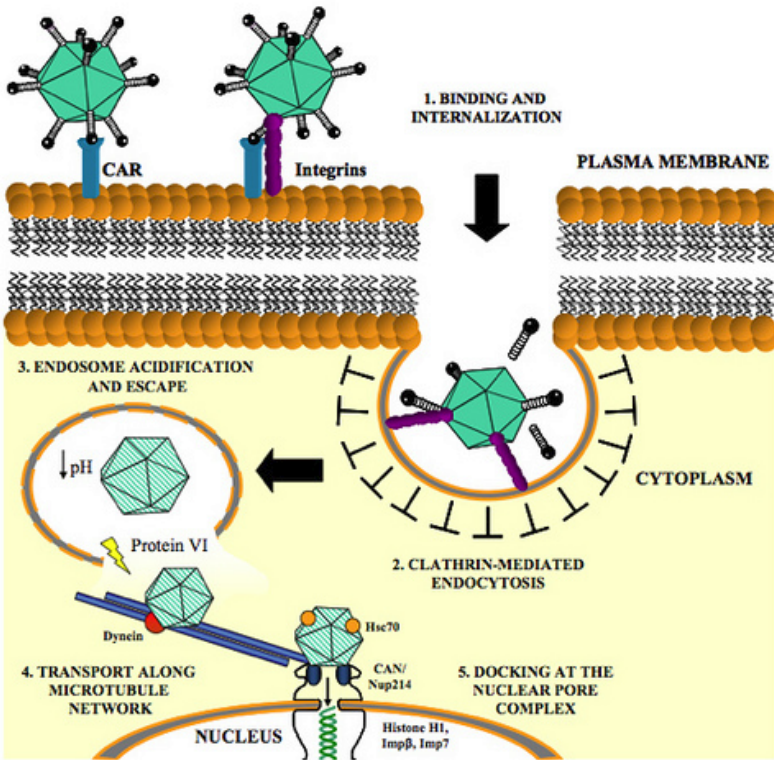
- Genetic material either for gene expression or downregulation
- Vector to carry the genetic material inside the cells

Expression Vector (Plasmid)





Non-Viral Vector



Viral Vector

Gene Transfer

- **Transformation:** introduction of genetic materials into bacteria
- **Transfection:** introduction of genetic materials into eukaryotic cells (e.g. fungi, plant, or animal cells)
- **Transduction:** introduction of genetic materials *using* viruses
- **Lipofection:** introduction of genetic materials *using* liposomes

Stable vs. Transient Gene Transfer

- **Stable Gene Transfer:** achieved by plasmid integration in the host genome or episomal replication of the transferred plasmid.
- **Transient Gene Transfer:** the foreign DNA is usually not integrated into the nuclear genome and will be degraded or diluted through mitosis

Gene Therapy Strategies

- **Replacement of a missing or defective gene**
- **Introduction of gene(s) to influence cellular process**
- **Interference with gene products**

You are now able to:

- ✓ Define the term “Gene Therapy”
- ✓ Use the correct terminology for gene transfer
- ✓ Realize the significance of gene therapy research