Medical Biotechnology 2024'

Biological therapies

Lecture 1-2nd

Definition. History. Main fields

Main therapeutic fields in human medicine

- Surgical treatments
- Conservative therapies
  - drug-based therapies
  - **biological therapies**
- Radiotherapies
- Physiotherapies
- Balneotherapy
- Psychotherapy

Definition of the biological therapy

- A type of treatment that uses substances made from living organisms to treat disease. These substances may occur naturally in the body or may be made in the laboratory. Some biological therapies stimulate or suppress the immune system to help the body fight cancer, infection, autoimmune and other diseases.
- Other biological therapies attack specific cancer cells, which may help keep them from growing or kill them.
- Types of biological therapy include immunotherapy (such as vaccines, cytokines, and some antibodies), gene therapy, and some targeted therapies or the biological response modifier therapies (BRM).

Main branches in biological therapies

Treatment or prevention of diseases with

- substances derived from living organisms, such as certain drugs, vaccines, IVIG, or antitoxins, etc.
- genetically engineered, recombinant, humanized biomolecules, such is monoclonal antibodies, gene therapies, etc.
- living organisms, such as oncolytic viruses or zoo-therapy using maggot, larva, leaches, honey bee, etc.

History

- Vaccination: *Edward Jenner*
- Active and passive vaccines, immunoglobulin therapy: *Louis Pasteur*
- Tumor immunotherapy: *William Coley* (Streptococcus pyogenes injection into bone tumours)
- Idea of combination of bio- and chemotherapy: *Paul Ehrlich*: ”magic bullet” (therapeutical monoclonal antibodies)
- Tumor vaccines and gene therapy: *Steven Rosenberg*

Main classes of biological therapies

- Based on academic research, and validated in evidence based experimental and clinical studies (E.g. therapeutic monoclonal antibodies, recombinant hormones and cytokines)
- Partially based on academic research but not validated by large scale evidence based studies (E.g. tumor vaccines)
- Based on empiric observations, not validated by evidence based studies (E.g. maggot therapy, some procedures of complementary medicine)
- Based on theories never approved by the academic research (E.g. oncolytic viruses, other methods of natural and alternative medicine)

Main forms of biological therapies

- Vaccines
- Immune-based therapies
- Gene therapies
- Therapeutic application of recombinant (human) biomolecules
- Living organism for human medical treatments

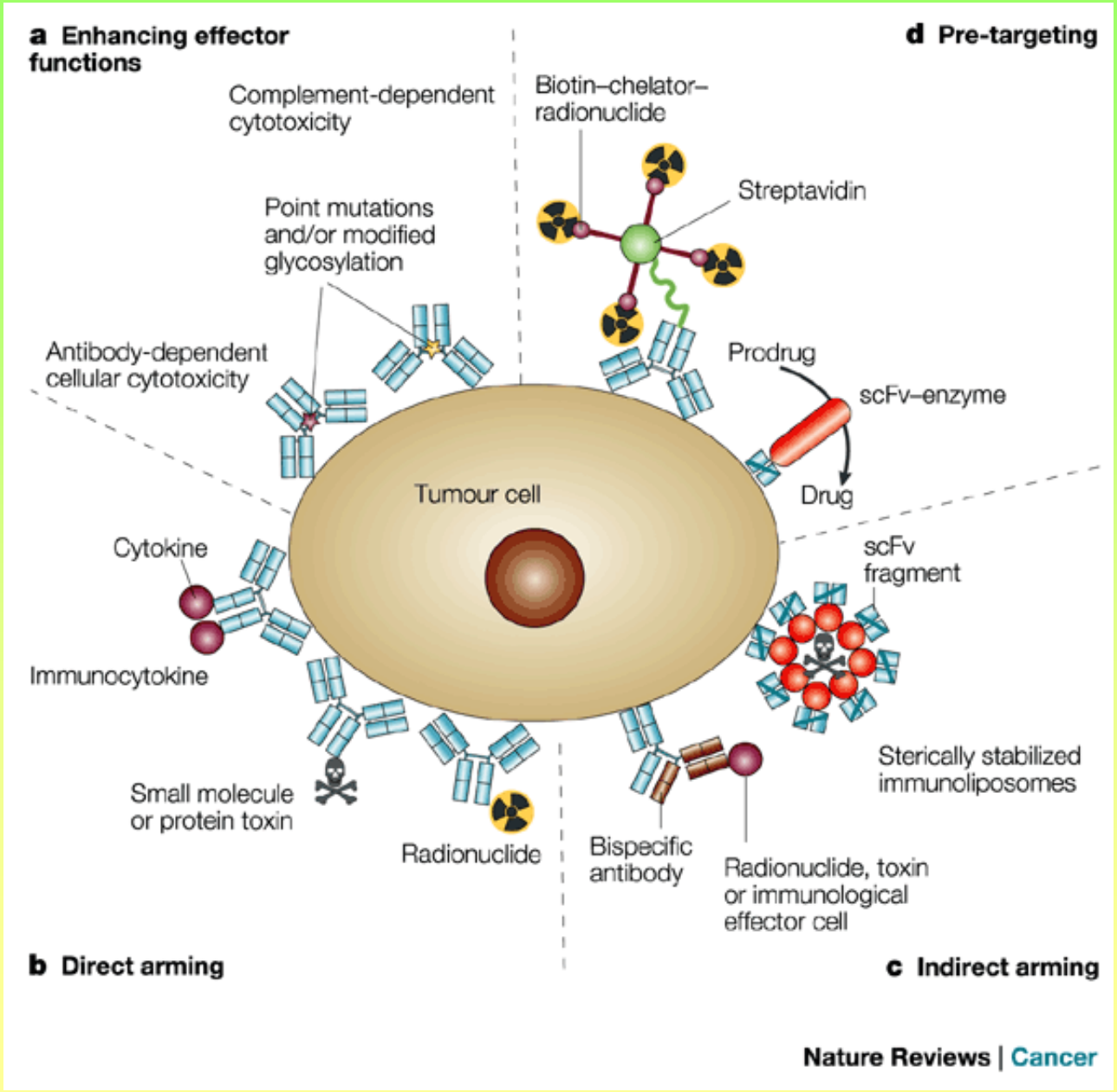
Biotherapy of autoimmune diseases

Biologic therapies for rheumatologic diseases, which are targeted at molecules involved in the mechanisms of the immune system, provide an alternative to the existing treatment methods of disease-modifying anti-rheumatic drugs and other immunosuppressive medications. However, the current drawbacks of biologic therapies, including the inconvenience of intravenous administration, the high costs of these drugs, and the adverse events associated with them, prevent their wide use as first-line medications.

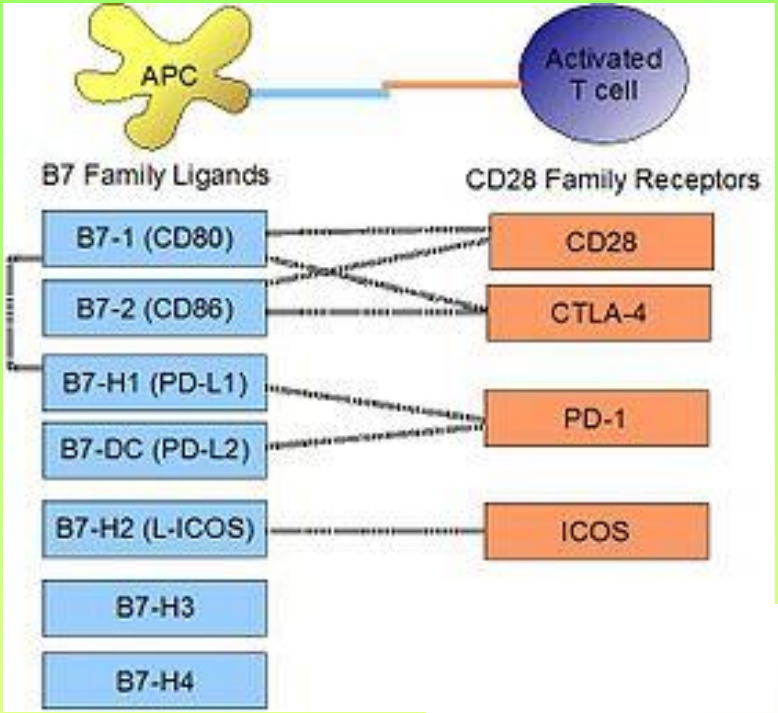
Immune based biological therapies of cancer

- Direct immunotherapy uses a variety of methods and drugs to manipulate the immune system to create a hostile environment for the cancer in the body.
- In indirect biological therapy the biologically derived agents are either used to modify the relationship between tumor and host, (E.g. check point inhibitors) Common biological agents include *interferons, monoclonal antibodies, interleukins, growth factors, and tumor vaccines*.
- Cytotoxic therapy involves changing the cancer cells' biology so that they become weak and die.
- Stem cell or bone marrow transplantation is often used to replace stem cells destroyed by high doses of chemotherapy and/or radiation therapy, or to directly attack the malignancy.

Monoclonal antibodies for therapeutic use



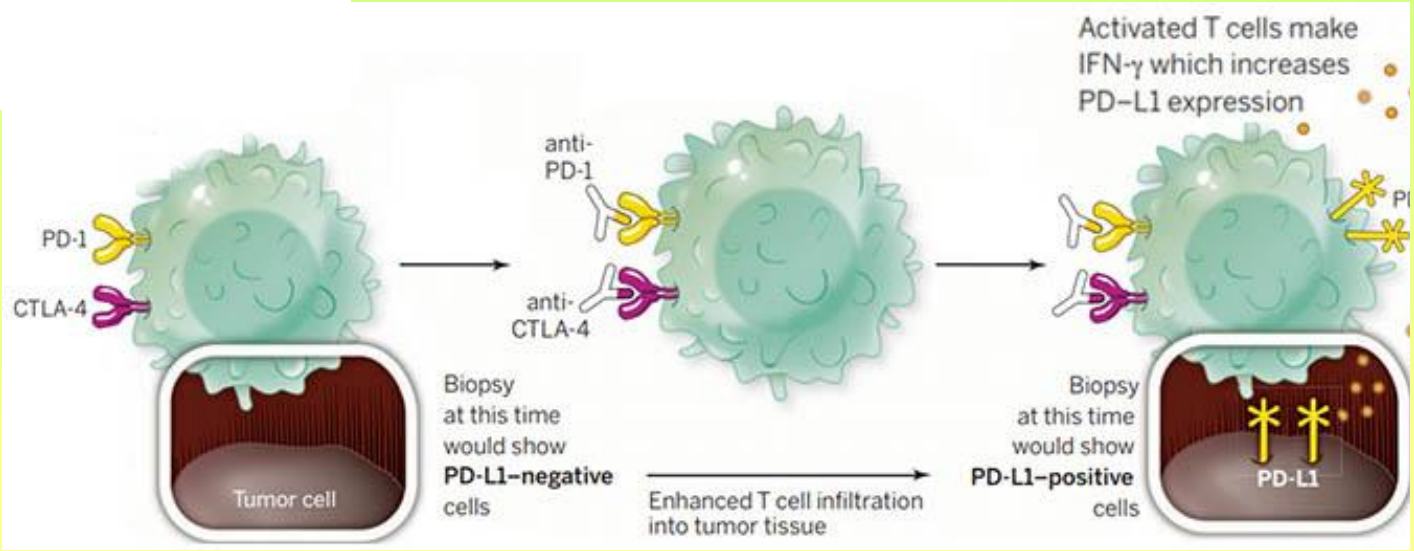
Checkpoint inhibitors



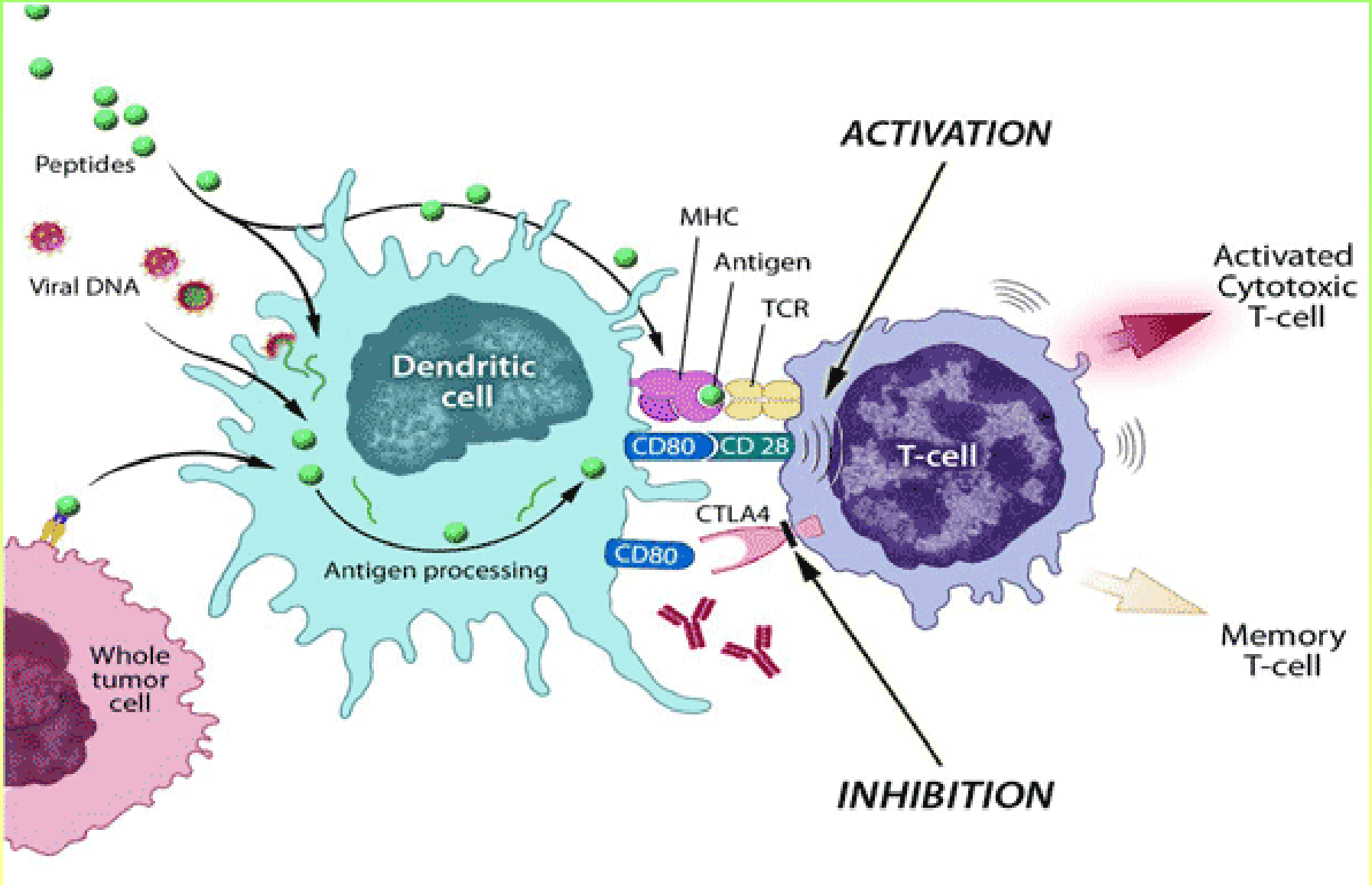
Blocking of CTLA-4, PD-1 and PD-L1 using monoclonal antibodies is able to delete the T cell inhibition induced by cancer cells.

Blocking the T cell blockade = T cell activation

Blockade of Immune Checkpoints



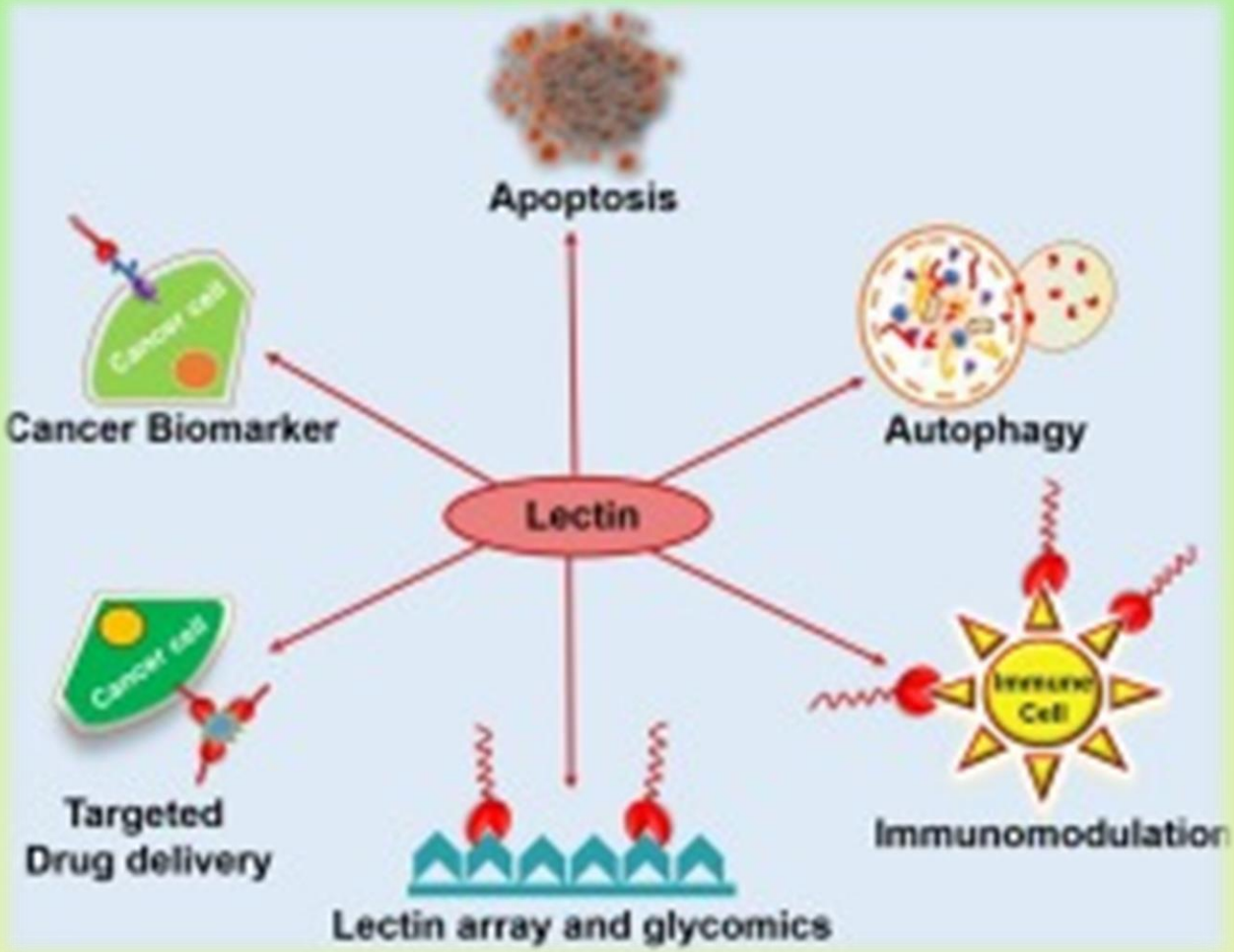
Cancer vaccines



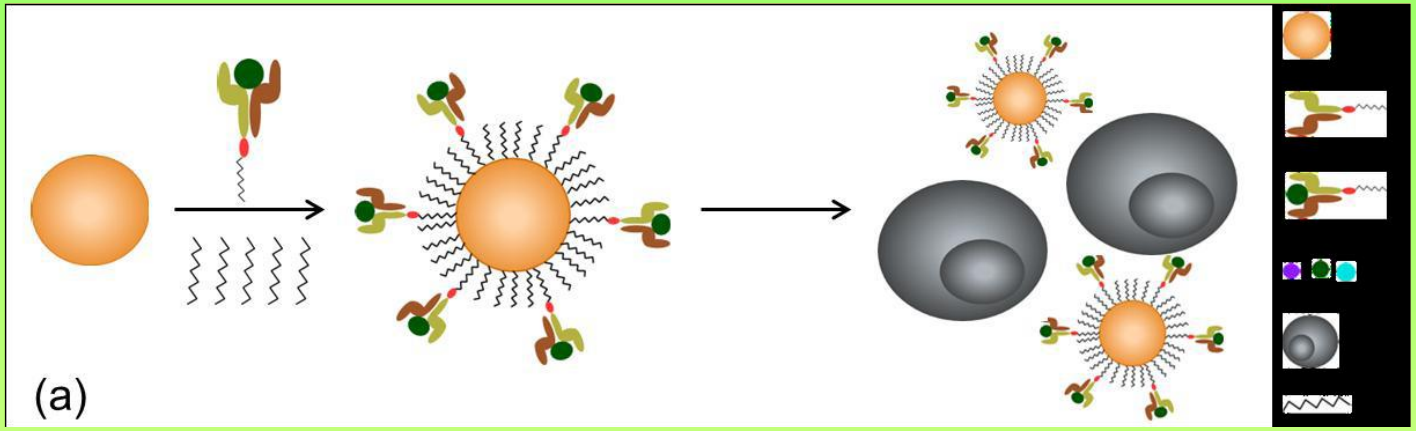
Techniques for modification of immune response

- Phytotherpy with plant lectins
- Appliation of arteficial nanoparticles
- Virus therapy against cancer

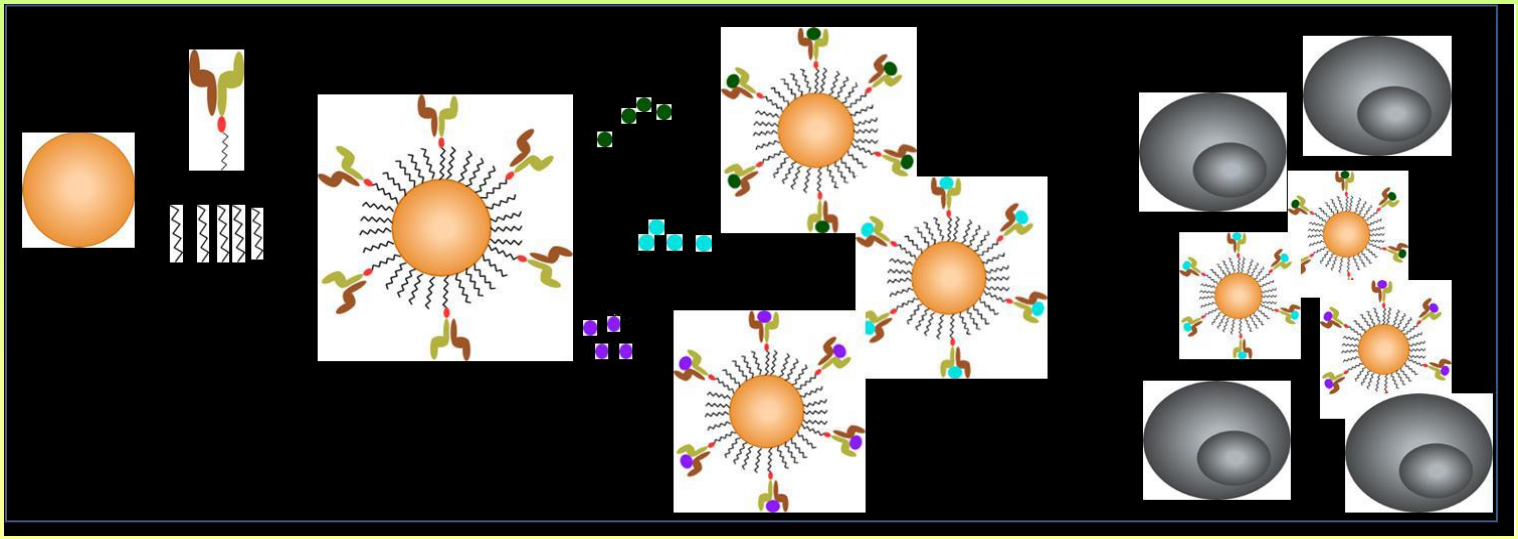
Plant lectins for biological therapy



Nanoparticles with biological activity for therapeutic use

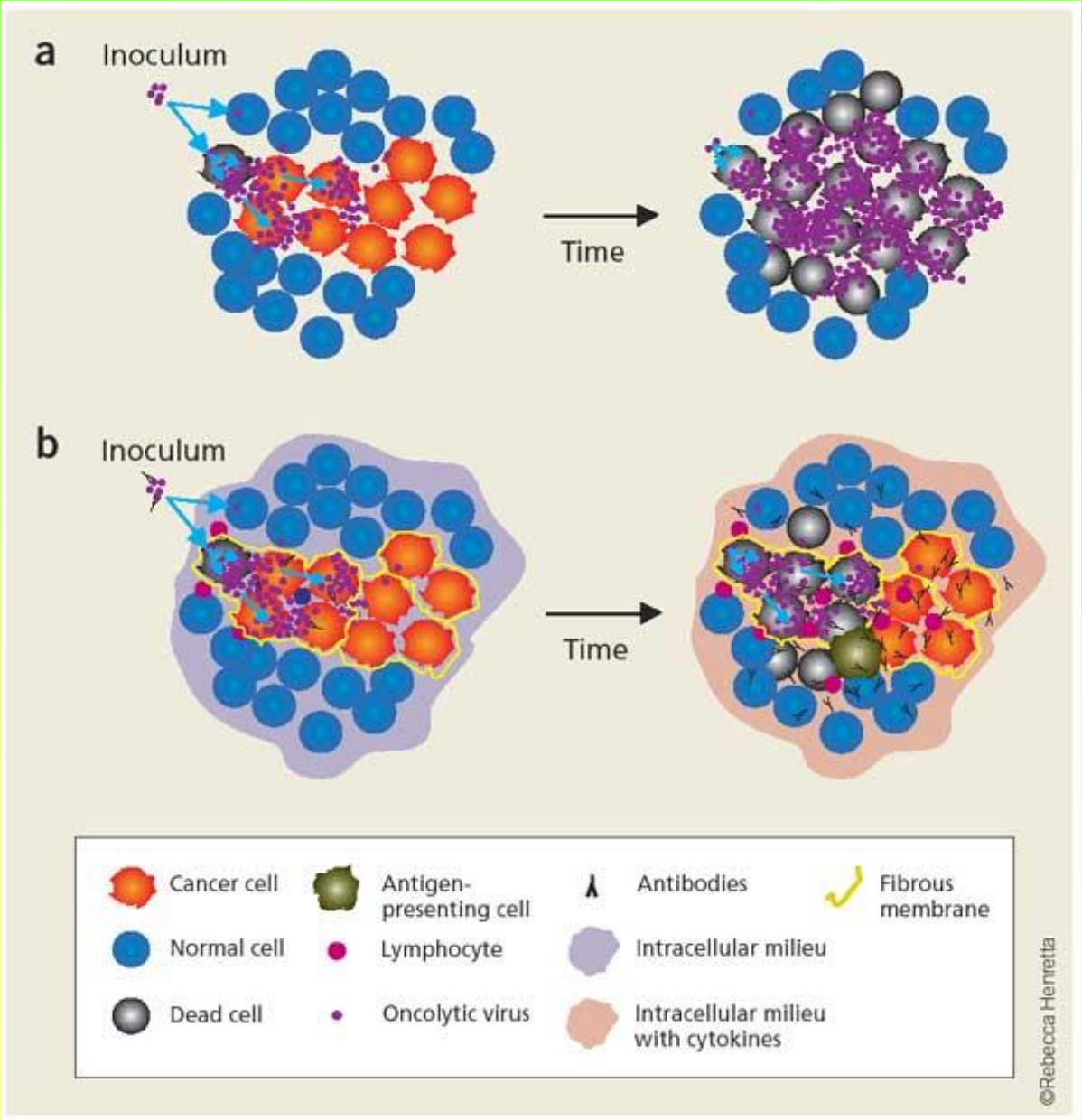


(a) Gold Nanoparticles are functionalized with PEG + MHC-peptide complexes. The functional NPs are designed to interact with T-Cells.

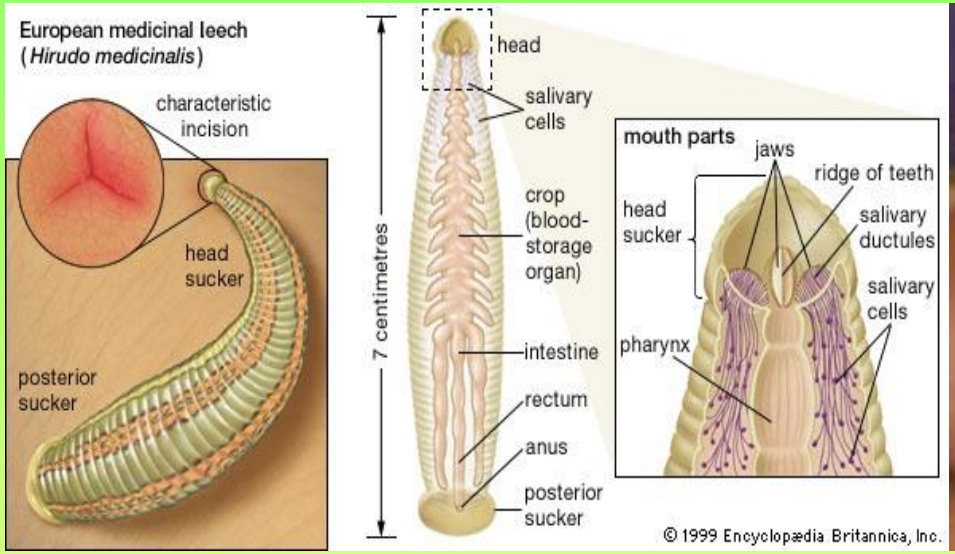


(b) NPs are functionalized with PEG+MHC complex, free of peptides. Various peptides are then loaded on the MHC NPs. The functional NPs are designed to interact with T-Cells

Oncolythic viruses



Zoo-therapy



Madam Fatimah undergoing leech therapy for her swollen foot at her flat in Sembawang recently. "Before this, my foot was like an elephant's," she said. ST PHOTO: TEH JOO LIN

The most common complication from leech treatment is prolonged bleeding, although allergic reactions and bacterial infections may also occur.

Fields of biotherapies will be discussed

- Therapeutic monoclonal antibodies
- General conditions of protein therapies
- Vaccination (preventive and curative vaccines)
- Recombinant cytokines, hormones, differentiation factors
- In vitro tumor vaccines
- Tumor gene therapy
- Tissue engineering
- Nanoparticles with biological functions
- Oncolytic viruses
- Zoo-therapies