

BENG 100 Frontiers of Biomedical Engineering
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Chapter 14

SUMMARY

- Biomolecular engineering uses the principles of chemical engineering, and the tools of modern biology, to find new solutions for human health care.
- All drugs have side effects that limit their use, but controlled drug delivery systems can extend and optimize drug use.
- Polymer materials have many potential uses in drug delivery, serving as vehicles for drug distribution and release.
- Tissue engineering is a rapidly evolving area, in which cells and synthetic materials are assembled into tissue-like units for organ replacement and repair.
- Nanobiotechnology involves the design of materials with nanoscale dimensions, which provides them with unique abilities to interact with biological systems.

KEY CONCEPTS AND DEFINITIONS

acellular – not containing cells

allogenic cells – cells from the same species that are genetically different but can be used for transplantation.

analgesics – drug agents that help to relieve pain, also referred to as “painkillers”.

antibodies – a large Y-shaped protein that is used in the immune system to identify and counteract invaders such as viruses, bacteria, or transplanted organ by binding to the antigen.

anticoagulants – a substance found in the blood that prevents clotting

artery occlusion - blockage or closure of an artery.

autografted cells – cells that have been removed from one part of an individual’s body and placed in a different location on the same individual.

biodegradable polymers – a compound of many covalently linked molecules forming a

high total molecular weight with the ability to be broken down by biological agents in the body.

biomolecular engineering – a field of engineering that examine the changes in chemical components within a biological system and develop methods for modifying these chemicals or their interactions

bioprocess engineering – a subspecialty of engineering that focuses on the conversion of materials through a process that makes them more useful to humans. Applications include: biofuels, food and drug processing, and fermentation systems.

bioreactors – an apparatus used in the growth of organisms such as cells or bacteria that forms a biologically active environment.

biopsy - a medical procedure involving the removal of cells or tissues from a patient for examination,

blood transfusion – the transfer of blood from one individual to another individual with a compatible blood type.

catheters – a hollow tube that is inserted into a cavity of the body to provide a route for drainage or insertion of fluids and access for medical instruments. For instance, a catheter can be inserted into the urethra to remove urine from the bladder.

cellular engineer – a type of biomolecular engineer who uses functional genomic concepts to predict changes in cellular function with gene expression, regulation of cellular function by ligand binding to receptors and intracellular signaling networks.

chemical engineering – the application of engineering and chemistry to the design and maintenance of industrial processes.

chemotherapy drugs – medicines used in the treatment of cancer.

chondrocyte – mature cells found in cartilage matrix.

crosslinked – molecules that have been joined by the creation of chemical covalent bonds.

cul-de-sac – a vessel, tube or sac e.g. cecum, open at only one end

degradable scaffolds – a mesh framework or matrix that is able to be inserted into the body for cell culture or tissue replacement and has the ability to breakdown under biological conditions.

DNA molecules – nucleic acids of helical structure found in the nuclei of cells that contain the genetic instructions for an organism's structure and development.

drug delivery – the study and administration of drugs through the use of controlled release technology and polymers that allow the drug to be encapsulated and released from the polymer in a controlled manner.

elastomers – plastics, either synthetic or natural, that are made up of polymerized chain units with elastic properties.

endothelial cells – cells found on the interior of blood vessels, forming a simple squamous layer.

enzymes – proteins produced by living organisms that biochemically catalyze reactions.

epidermal – from the outermost layer of skin.

extracellular matrix – any part of a tissue that is not considered part of a cell, including components such as collagen and glycoproteins.

feedback control – a control system that is setup to monitor itself and change the output conditions accordingly to regulate the system.

fibroblast cells – a type of cell found in connective tissue with the ability to secrete proteins and collagen.

fibronectin - a fibrous protein that forms as an anchor between cell membranes by attaching to integrins and other extracellular matrix components such as collagen, fibrin, and other proteins.

growth factors – proteins that assist in the organization, growth, and differentiation of cells and tissues.

human growth hormone – any natural or synthetic substances that control the development and growth of an organism and its cellular components.

HUVEC – human umbilical vein endothelial cells

hydrogel –crosslinked, water-soluble polymer networks that swell in water to form a soft, but stable, material.

immunosuppressive drugs – drugs that inhibit the normal activity of the immune system, typically used to prevent the rejection of a transplanted organ and to treat autoimmune diseases.

insulin – a polypeptide hormone produced in the pancreas that helps to regulate the metabolism of carbohydrates in the body.

intrauterine – within the uterus.

irradiated – having been exposed to radiation such as x-rays or gamma rays.

ligands – any molecule, other than an enzyme substrate, that binds tightly and specifically to a macromolecule, usually a protein, forming a macromolecule-ligand complex.

liposomes – an artificial vesicle with an aqueous core and a surrounding phospholipid bilayer used to transport drugs, enzymes, or vaccines to cells and organs within the body.

matrices – a biocompatible surface, commonly made from titanium or polymers, that can be inserted into the body to function as a mechanism for drug delivery or as a tissue replacement to provide for cell attachment and proliferation.

metabolic engineering – the study of the metabolism of cultured cells and the manipulation of culture conditions to control cellular function and metabolic activity.

microparticulates - drug encapsulated particles of the micrometer range that can be used as a controlled drug delivery mechanism within the body.

micelles – a spherical aggregate of amphipathic molecules that form due to hydrophilic “head” groups on the outer solvent exposed surface and hydrophobic “tails” in the protected interior.

molecular motors – cellular components used in movement of the body that are able to take in chemical energy from ATP hydrolysis and convert it to mechanical work.

nanotechnology – a field of study focusing on the development, characterization, and application for materials of nanometer scale.

nondegradable polymers – a compound of many covalently linked molecules forming a high total molecular weight that will not be broken down by biological agents in the body.

overexpression – excessive expression by a gene in the body that causes an overproduction of gene products.

perfuse – the delivery of arterial blood to the capillaries of the body.

plasma – the liquid component of blood that suspends the blood cells and assists in the delivery of oxygen, carbon dioxide, lipids, amino acids and other biological components throughout the body and contains clotting agents such as fibrin.

polymer – a compound of many covalently linked molecules, or monomers, forming a high total molecular weight chemical compound.

polypeptides – a family of molecules consisting of many subunits of α -amino acids that have been linked together by amide bonds.

recombinant proteins – a protein that is produced by an organism after it has been genetically modified and a new DNA sequence has been inserted.

recombinant tissue plasminogen activator – a tissue plasminogen activator that is produced by recombinant DNA technology; tissue plasminogen activator is an enzyme that helps to dissolve blood clots.

ribosomes – organelles found within cells that translate messenger RNA into proteins.

skin grafts – skin that is used in a transplant.

subcellular – restricted anything within a cell.

synthetic – formed through human chemical processing as opposed to being obtained in nature.

systemically – pertaining to the body as a whole.

tissue engineering - combines knowledge from the biological sciences with the materials and engineering sciences to quantify structure-function relationships in normal and pathological tissues, to develop new approaches to repair tissues, and to develop replacements for tissues.

transdermal – applied through application to the skin.

type I collagen – the primary protein of connective tissues composed of fibers in the extracellular matrix. Type I is the most abundant form in the human body.

vasculature – the arrangement of blood vessels found in a particular part of the body.

viruses – microscopic protein coated parasites with cores of DNA or RNA that cause diseases in animals, plants, or bacteria. Viruses can only replicate with a host cell.