ASSIGNMENT - 5

INNOVATIVE TECHNOLOGY AND BIO-SCIENCE

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Q1. What do you understand by regenerative medicine?

Regenerative medicine is the branch of medicine that develops methods to **regrow, repair or replace damaged or diseased cells, organs or tissues**. Regenerative medicine includes the **generation and use of therapeutic stem cells, tissue engineering and the production of artificial organs**.

There is possibility for regenerative medicine to treat both chronic diseases and acute injuries, and assist treatment of various ailments occurring across a wide array of organ systems and contexts, including dermal wounds, cardiovascular diseases and traumas, treatments for certain types of cancer etc. **The current therapy of transplantation of intact organs and tissues to treat organ and tissue failures and loss suffers from limited donor supply and often severe immune complications**, but these obstacles may **potentially be bypassed** through the use of regenerative medicine strategies.

The **delivery of therapeutic cells** that directly contribute to the structure and function of new tissues is a **principle paradigm of regenerative medicine** to date. The cells used in these therapies are either autologous or allogeneic and are typically differentiated cells that **still maintain proliferative capacity like stem cells**. Stem cells can be obtained at embryonic stage and may be used naturally or after genetic manipulation to derive a certain functionality.
Some commercially tested examples of regenerative medicine are :

Category	Name	Biological agent	Approved use

Biologics	Carticel	Autologous chondrocytes	Cartilage defects from acute or repetitive trauma
	Cord blood	Hematopoietic stem and progenitor cells	Hematopoietic (manufacturing of blood cells) and immunological reconstitution
Cell-based medical devices	Dermagraft	Allogenic fibroblasts	Diabetic foot ulcer
	Celution	Cell extraction	Transfer of autologous adipose stem cells
Biopharmaceuticals	GEM 125	PDGF-BB, tricalcium phosphate	Periodontal defects
	Regranex	PDGF-BB (Platelet derived growth factor)	Lower extremity diabetic ulcers

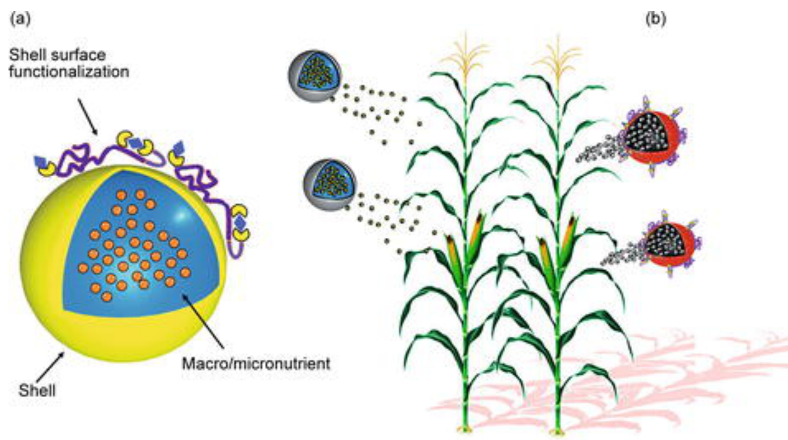
Q2. Explain nanobiotechnology in agriculture

Nanobiotechnology is a recently coined term describing the convergence of the two existing, however distant, worlds between nano-technology and molecular biology. It is believed that a combination of these disciplines will result in a new class of multifunctional devices and systems for biological and chemical action characterized by better sensitivity and specificity and higher rates of recognition compared with current solutions. This finds applications in agriculture to solve many of the existing problems. Currently, some of the solutions to cope with those problems have been the
use of **fertilizers, pesticides and genetically modified organisms (GMO)**. Nevertheless, the indiscriminate use of chemical compounds to increase the crop production or efficiency, has caused serious issues like heavy soil, air and water contamination, human and animal diseases and destabilization of the ecosystems. For example, related to the overuse of pesticides, many of the pests that affect the crops have developed resistance, analogous to the bacterial antibiotic resistance, which causes that the farmers tend to use more quantity and strong pesticides some of them being quite toxic.

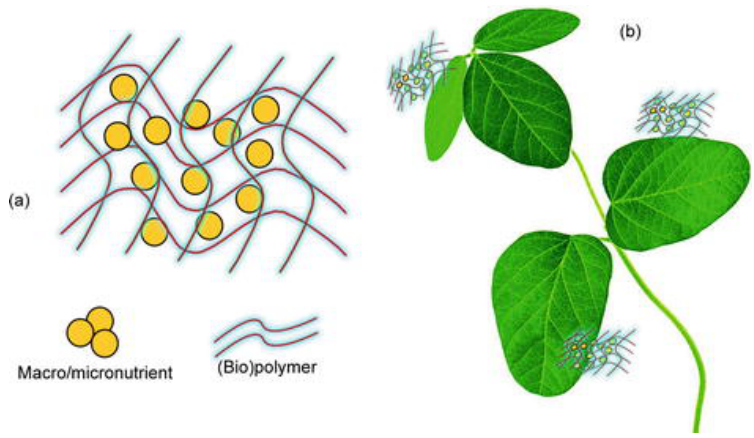
NANOFERTILISERS

Use of conventional fertilizers at high rates and long periods of time, which is the main anthropogenic factor that has caused the **eutrophication of coastal and freshwater ecosystems**. The design of **smart fertilizers** strongly influences the nutrient release and the minimization of losses. In field conditions such products are

provided to crops via irrigation or sprayed to plant canopies. Through the application of nanotechnologies in agriculture the fertilization will be carried out in different ways. In particular, the nutrient elements will be possibly administered as follows:
Delivered as particles or emulsions of nanoscale dimensions (e.g., **fullerenes, carbon nanotubes, $nTiO_2$, and $nSiO_2$)** in different growth stages of crops may partially replace traditional fertilizer practices.
Encapsulated inside nanostructures designed to allow the controlled release of nutrients to do so the outer shell of nanocapsules is engineered and programmed to **open when stimulated by environmental factors or man-induced pulses**. Here are some examples of possible control mechanisms.
Delivered in a complex formed by **nanocapsules incorporated in a matrix of organic polymers of biological or chemical origin which act as a carrier** : Both of them provide the expected traits to nanofertilizers and release of nutrients is a functon of time or environment conditions. Potential materials such as **zeolites, polyacrylic acid and chitosan** are being tested.



(a) Model of nanocapsule containing macro/microelements. Examples of opening strategies of nanocapsule: (b) release of nutrients as function of time to avoid or limit nutrient losses or designed to occur when a molecular receptor binds to a specific chemical.



(a) Model of biopolymeric structure containing macro/microelements. (b) Deposition onto the crop leaf after spray treatment.

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Some materials contain elements in the nanometer size that claims novel properties associated with these small size, in this way, nanopesticides are defined as any formulation that includes this type of modified materials to generate more efficient products. Since materials vary their properties depending on their size, there is a wide range of nanopesticides that cannot be considered as a single category. Some of them are made of organic ingredients like polymers, some may have inorganic ingredients like metal oxides. It should be noted that the **nanomaterials were introduced into pesticides in various forms (particles and micelles);** and this nanometric materials are introduced into pesticides to **release the active ingredient more slowly and in a selectively way to increase the solubility of the poorly soluble active ingredient o thereby protect the ingredient against premature degradation**

Q3. Use of nanotechnology in cancer treatment?

Tumour Targeting

The **ability to differentiate malignant cells from nonmalignant** and to **selectively eradicate** malignant cells is central to the mission of nanotechnology as it relates to cancer treatment. Two fundamental processes are involved in differentiating malignant and nonmalignant cells: **passive and active targeting**. Passive targeting takes advantage of the enhanced permeability and retention (EPR) effect to increase the concentration of nanoparticles (NPs) in the tumor. Active targeting may involve selective molecular recognition of antigens, frequently proteins, that are expressed on the surfaces of cancer cells in order to localize NPs to malignant cells or, alternatively, exploits biochemical properties associated with malignancy such as matrix metalloproteinase secretion

Nanoparticle mediated cancer imaging

NPs may be highly useful for imaging applications because of the high surface area-to-volume ratio (relative to larger particles) as well as having the potential for numerous sites for chemical modification that may be used to **amplify imaging sensitivity.**

Nanoparticle mediated cancer treatment

Nanoparticle mediated drug delivery

NP-mediated drug delivery is based upon the premise that it is, for the most part, **no more difficult to kill a cancer cell than any other nonmalignant cells**.

NP assisted thermal ablation for cancer treatment

NP mediated radiologic guidance can improve tumor specificity increasing the efficacy of cancer therapy. It is important to note that micrometastatic disease, particularly at sites distant from the primary tumor, is an extremely poor prognostic indicator. Thus, the application of nanotechnology approaches for **eradicating micrometastatic disease** represents one of the most important objectives for using nanotechnology for cancer treatment.

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