Tissue Engineering And Regenerative Therapies

The ability of tissues to undergo spontaneous repair and regeneration is highly variable and, in most cases, limited. This has driven the development of approaches that harness the biology at the site of tissue damage to mediate regeneration through the localized delivery of cells, materials and molecules

Examples: للاطلاع

TABLE 4.1 Examples of tissues created by tissue engineering and conditions they may be used to treat.

Tissue	Conditions treated
Skin	Burns and skin defects after excision or trauma
Eye	Retinal and corneal disease
Cardiac muscle	Heart failure
Heart valves	Congenital and acquired valvular heart disease
Cartilage and bone	Degenerative and traumatic bone and joint disorders
Trachea and bronchus	Congenital and acquired stenosis and resection for malignancy
Bladder	Congenital bladder malformation and cystectomy
Anal/bladder sphincter	Incontinence
Pancreatic islets	Insulin-dependent diabetes
Large blood vessels	Atheromatous, aneurysmal and traumatic arterial disease
Oesophagus	Benign stenosis and resection for malignancy
Small intestine	Intestinal failure after surgical resection for Crohn's disease, cancer or ischaemia

Stem Cell : undifferentiated or non-specialized cells that are able, through cell division, to renew themselves indefinitely (self-renewal). Crucially, they are also able, when provided with appropriate stimuli, to differentiate into one or more of the different types of specialized cell found in tissues and organs (potency). Because of their unique ability to undergo self-renewal when cultured in vitro and to be directed to differentiate into specialized cell types, they have enormous potential for use as cell-based therapies or, by way of their different characteristics, to otherwise contribute to regenerative medicine. Stem cells can be classified in different ways, for example by using their characteristic level of potency such as pluripotent and multipotent or with reference to the tissue from which they are derived, for example the early embryo (embryonic stem cells [ESCs]), later in development (SSCs) or whether they are derived by reprogramming adult specialized cells to a pluripotent state (iPSCs).

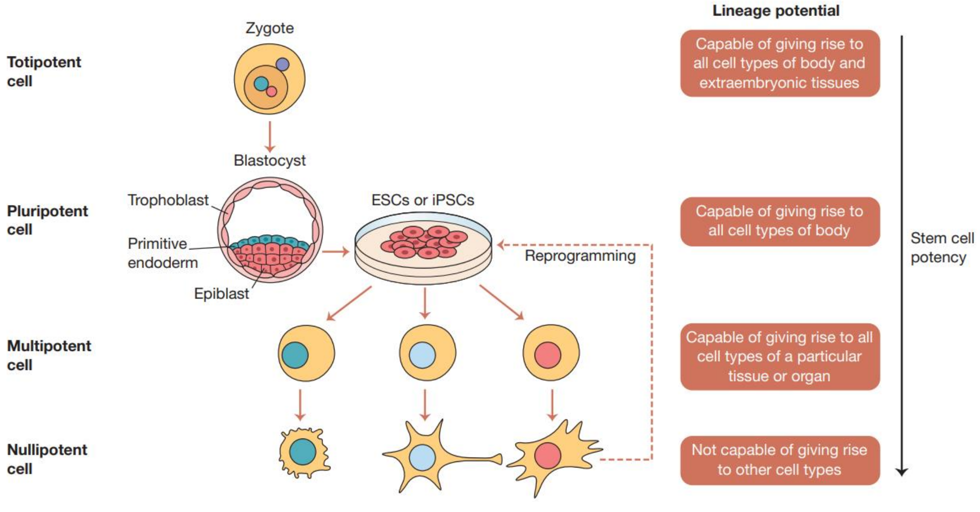
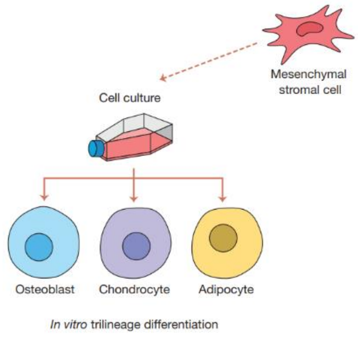


Figure 4.2 Hierarchy of cells according to potency, ranging from stem cells to specialised differentiated cells. ESC, embryonic stem cell; iPSC, induced pluripotent stem cell. (Adapted with permission from Tewary M, Shakiba N, Zandstra PW. Stem cell bioengineering: building from stem cell biology. *Nat Rev Genet 2018*; **19**: 595–614.)

MSCs can be isolated from bone marrow (iliac crest aspiration) or from subcutaneous fat (liposuction/lipoaspiration).

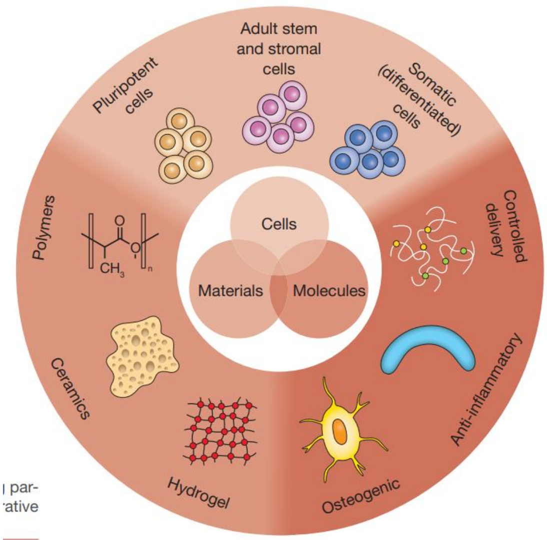


Materials: A large number of materials have been used in tissue engineering and regenerative medicine, either as delivery vehicles or as scafolds; materials can be either natural or synthetic polymers, hydrogels and osteoinductive ceramics such as Bioglass®.

Molecules Modifcation of the tissue environment during healing can be achieved by the delivery of molecules that are selected and able to specifcally modify biological responses at the site of injury. In terms of tissue regeneration, these molecules can modulate the infammatory environment, either by enhancement or by inhibition of specifc biological response pathways, such as angiogenesis. This approach has been used to optimize tissue regeneration across several applications, with specifc examples, for the skin TGFβ3 and the eye TGFβ1 to prevent scarring.

TABLE 4.3 Risks of cell-based therapy.

- Tumour formation
- Genetic and epigenetic abnormalities
- Transmission of infection
- Poor viability and loss of function
- Differentiation to undesired cell types
- Rejection (allogeneic cells)
- Side effects of immunosuppression (allogeneic cells)



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