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Definitions

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Abstract

This chapter summarises key definitions commonly used in the field of bone grafting and biomaterials within the craniofacial region. The terminology presented throughout this chapter is derived from current and authoritative literature and is intended to provide a conceptual framework for researchers, clinicians, and postgraduate students. Clear understanding of these definitions facilitates interpretation of biological mechanisms, material behaviour, and assessment parameters discussed in subsequent chapters, including those related to osteointegration, bone–implant contact (BIC), and radiostereometric analysis.

***Keywords*:** Radiostereometric, alloplasts, allograft, graft, flap, bioactive material, bone–implant contact, biomimetic graft

1.1 Definitions

1.1.1 Allografts

Allografts are tissues harvested from one individual and transplanted into another genetically non-identical individual of the same species. In oral and maxillofacial applications, the most commonly used forms include demineralized freeze-dried bone allograft (DFDBA) and freeze-dried bone allograft (FDBA) [1].

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1.1.2 Alloplasts

Alloplasts are synthetic materials that contain some of the essential chemical constituents of normal bone and are used to promote bone regeneration. When it comes to osteoinduction and osteogenesis, the ideal alloplastic bone substitutes behave similarly to autologous bone [2].

1.1.3 Antibody

B-lymphocytes that are produced by bone marrow and have the capacity to develop into plasma cells produce the remarkable proteins known as antibodies. Antibodies are adaptor molecules that can attach to microorganisms, activate complement, and attach to phagocytic cells. The Fab end of the molecule, which binds microorganisms, is a specific recognition site for each antibody. The antibody molecule's Fc end has domains that can attach to phagocyte Fc receptors and bind and activate the first component of complement. There are five antibody subtypes: IgG, IgM, IgA, IgD, and IgE [3].

1.1.4 Antigen

Any type of molecule that may be identified by particular adaptive immune system receptors on T and B cells is considered an antigen. They can be proteins or protein peptide fragments, carbohydrates, lipids, nucleic acids (DNA or RNA), or even haptens. To be considered immunogenic, an antigen must be able to both activate the immune system and be recognized by the immune system (antigenic), usually as foreign body [4].

1.1.5 Autogenous

Autogenous grafts are tissues transferred from one site to another within the same individual. They are considered the most biologically effective graft material due to their osteogenic, osteoinductive, and osteoconductive properties and are widely regarded as the reference standard in bone regeneration procedures.

1.1.6 Bone–Implant Contact (BIC)

The BIC is the ratio of the overall length of the implant profile to the linear measurement of the surface of the implant that is in direct contact with bone. Previously, this interface was described as "a direct structural and functional connection between ordered, living bone and the surface of a load-carrying implant" made by highly differentiated tissue [6].

1.1.7 Bioactive Material

Bioactive materials are characterized by their ability to elicit a specific biological response at the interface with host tissue, resulting in the formation of a biologically active layer typically calcium phosphate that facilitates bonding between the material and surrounding bone.

1.1.8 Biodegradation

Biodegradation refers to the biologically mediated breakdown of a graft material through cellular and enzymatic processes within the host microenvironment.

1.1.9 Bioengineered Graft

Bioengineered grafts are advanced synthetic or hybrid constructs designed to replicate biological functions of autogenous grafts by incorporating regenerative biomaterials, cells, or bioactive molecules.

1.1.10 Bioinert Graft

Bioinert graft is a graft material that, when introduced into a biological tissue, does not initiate a response or interact with the tissue. It is a substance that elucidates minimal interaction with its surrounding tissue and/or does not trigger a response from the host immune system [10].

1.1.11 Biomaterials

Biomaterials are natural or synthetic materials specifically designed to interact with biological systems for therapeutic or diagnostic purposes.

1.1.12 Biomimetic Graft

A biomimetic graft is a graft material that is designed to imitate the biological characteristics of natural tissues. The aim of biomimetic graft is to address a number of intricate biological issues, including inadequate tissue perfusion, drug delivery in biomedical settings, and the characterization of nanostructured biohybrid materials. It also intends to improve the structure, function, or production of materials and substances produced by biological processes [12].

1.1.13 Bone Graft

Bone graft is a material used to regenerate, reconstruct, or replace lost natural bone. Autogenic, allograft, xenograft, or alloplastic materials can all be used as a graft. The goal is to restore the function and continuity of lost bone [9].

1.1.14 Bone Remodelling

Bone remodelling is a continuous physiological process involving coordinated bone resorption and formation.

1.1.15 Cell Surface Markers

Cell surface markers are molecules found on a cell's surface that are used to determine the type of cell. When these molecules bind to specific substances, they function as receptors that trigger a reaction or activity within the cell. They might also function as antigens, binding to specific antibodies [14].

1.1.16 Composite Bone Graft

A composite bone graft is a procedure that combines various graft materials to form a bone graft with the best biological characteristics and sufficient volume to support a prompt, effective bone repair response. These combinations can be made by combining two distinct biomaterials, natural and synthetic materials, or autogenous extracts such as growth factors, cytokines, and cells. Getting a synergistic effect in terms of biomimetics, optimal resorption time, and regeneration ability is the goal [15].

1.1.17 Cumulative Survival Rate (CSR)

The percentage of dental implants that remain functional over a given period of time is indicated statistically by the Cumulative Survival Rate (CSR). It is determined by dividing the number of surviving implants in a group by the total implants placed. This rate is a crucial dependability indicator that shows how well the implants work over time and aids in evaluating the implants' survival *in situ* [16].

1.1.18 Extracellular Matrix (ECM)

The extracellular matrix (ECM), a form of connective tissue present in the cell microenvironment, is crucial to tissue development. It is the non-cellular element present in every organ and tissue. In addition to providing the required physical scaffolding for the cellular components, it initiates critical biochemical and biomechanical signals required for tissue morphogenesis, differentiation, and homeostasis [17].

1.1.19 Graft

Tissue which is used to reconstruct a lost or damaged part is transferred from one site to another, depending on its revascularisation from the recipient site. This tissue can be from the same person, another human donor, an animal, or synthetic.

1.1.20 Gene Expression

Inducible gene expression is the term used to describe the quick activation of gene transcription that leads to the generation of new proteins as a result of external stimuli. In response to the same stimulus, it is frequently necessary for several genes to be synchronously activated so that the proteins needed to react to the stimulus are generated concurrently at the proper relative quantities. Similar to this, for the proper morphogenetic process to take place across a broad region of cells, several cells in an organism must react to develop signals in a coordinated manner [18].

1.1.21 Foreign Body Reaction

Following the implantation of biomaterials, host reactions known as foreign body reactions include granulation tissue development, fibrosis/fibrous capsule creation, acute and chronic inflammation, damage, blood–material interactions, and provisional matrix synthesis. Phases of the reaction include mast cells in the acute inflammatory phase and lymphocytes in the transient chronic inflammatory phase, which generate IL4 and IL3 and can cause monocyte/macrophage fusion to generate body giant cells [19].

1.1.22 Flap

Tissue which is used to reconstruct lost or damaged part is transferred from one site to another with its own blood supply. It depends on its revascularisation from its own blood vascular structure. This vascular pedicle tissue can be from the same person only. It is considered the gold standard for reconstructive surgery.

1.1.23 Immunohistochemistry

Immunohistochemistry is the gold standard of research techniques for identifying the presence of proteins (antigens). Based on a particular chemical interaction between antigens and antibodies, immunohistochemistry can identify individual antigens (proteins) in cells within a tissue segment. Either fluorescent or chromogenic immunostaining is typically used to visualize the antigen–antibody interaction [20].

1.1.24 Macrophages

Macrophages have significant immunological function and phenotypic heterogeneity, potentially changing into several cell subtypes upon encountering a variety of immune microenvironments. One essential macrophage activity for pathogenic host defence is autophagy. In addition to being additional stimulators and regulators of aging inflammation, tissue macrophages are key producers of inflammatory cytokines. Furthermore, macrophages are an essential component of the tumour microenvironment (TME) that subvert immune cells, which promotes the formation and progression of cancer cells with clinical significance [21].

1.1.25 Osteoblasts

The cells that comprise bone tissue are called osteoblasts. In order to regulate the ratio of calcium to phosphate ions in growing bone, they can produce and secrete bone matrix and take part in bone mineralization. Osteoprogenitor cells give rise to osteoblasts. Numerous factors, including different hormones and locally produced bioactive chemicals following fracture, influence the conversion of osteoprogenitors. These conditions allow osteoprogenitors to proliferate and start differentiating into osteoblasts, which perform osteogenic functions [22].

1.1.26 Osteocytes

In bone, osteocytes are the most common type of cell. Osteocytes regulate both bone production and resorption. The unmineralized matrix (osteoid) that surrounds the osteocytes, which are formerly osteoblasts, during bone formation traps the osteocytes in place and keeps them buried for the remainder of their lives. Given that they are arranged in networks, osteocytes can interact with other cells on the surface of bones as well as with one another [23].

1.1.27 Osteogenesis

Osteogenesis is the process by which mesenchymal stromal cells (MSCs) differentiate to become bone. Two distinct mechanisms are involved: either the skull's neural crest-derived mesenchymal cells proliferate and produce capillaries, or other cells transform into osteoblasts, committed bone precursor cells, and generate osteoid matrix. Sclerosome-derived cells are the alternative process, in which mesenchymal cells are dedicated to becoming cartilage cells and then convert into bone [24].

1.1.28 Osteoinduction

Osteoinduction is the process of attracting immature cells and stimulating their development into pre-osteoblasts. In other words, it is the process that promotes osteogenesis. This bio-stimulation process is brought on by the presence of cytokines, inflammatory substances, bone morphogenic proteins, or bioactive fourth-generation biomaterials [25].

1.1.29 Osteoconduction

Osteoconduction describes the ability of a graft material to serve as a scaffold that supports the ingrowth of bone.

1.1.30 Osteoclasts

Multinucleated large cells called osteoclasts resorb bone, which promotes the growth and ongoing remodelling of the skeleton and the bone marrow's hematopoietic niche. The discovery of the intracellular signals that mediate the cell's resorptive ability was made possible by the fact that the cell is hematopoietic and regulated by cytokines [26].

1.1.31 Osteointegration Graft

Osteointegration graft is a direct structural and functional bond between the surface of an implant or graft material and a living bone. It is the presence of an amorphous layer with an ultrastructure range of [2040–500] nm thick, composed of collagen and calcified tissue, near the bone–graft contact. This region is too small to be visible at the resolution of a light microscope. High biocompatibility is required for the graft material [27, 28].

1.1.32 Osteoid Matrix

Osteoid matrix is an extracellular organic matrix that is secreted by osteoblast bone cells, before the mineralized bone is formed. It is composed of a gelatinous material consisting of an organic glue called mucopolysaccharide and collagen, a fibrous protein [29]. The hardened substance known as mature bone is then formed by the subsequent deposition of inorganic salts.

1.1.33 Osteogenic Proteins

These polypeptides belong to the family of bone matrix and have been isolated from a range of mammalian species. These proteins belong to the superfamily known as transforming growth factor-beta. They are essential for triggering the differentiation of mesenchymal stem cells into osteoblasts, which promotes the growth of new bone. These proteins are known as bone morphogenic proteins 7 and 2 and bone sialoprotein BSP [30].

1.1.34 Radiostereometric Analysis

Radiostereometric analysis is the clinical evaluation of graft material integration. It is an accurate tool for measuring motion between supposedly rigid objects [31].

1.1.35 Regeneration

The act of replacing or regaining the complete function of injured or absent cells, tissues, organs, and even entire body parts is called regeneration. In order to maintain their tissues and organs, all living things, including plants and animals, have the capacity to regenerate to some extent [32].

1.1.36 Regenerative Medicine

Regenerative medicine is a multidisciplinary field focused on restoring, replacing, or regenerating human cells, tissues, or organs.

1.1.37 Reconstructions

The regeneration or augmentation of a damaged bodily part that was lost as a result of trauma, a degenerative body process, surgical resection, or a congenital imperfection is known as reconstruction. Both synthetic and biological biomaterials may be used for the reconstruction.

1.1.38 Rejuvenation

Rejuvenation is the act of reversing the aging-related alterations in soft tissue, which manifest as atrophic laxity that causes tissue descent. With a focus on lift vectors, this procedure seeks to red rape and reposition the tissues [34]. The mandibular region, the medial suborbital and pyriform regions of the maxilla, and the superomedial and inferolateral portions of the orbit are the sites of selective resorption associated with facial skeleton aging.

1.1.39 Reverse Torque Test

This is the maximum amount of force required to remove implants or the critical torque threshold where bone-implant contact is destroyed [35].

1.1.40 Scaffolds

A scaffold is a natural or artificial three-dimensional skeleton that aids in the growth of cells, the synthesis of extracellular matrix and other biological components, and the subsequent formation of functioning tissues or organs [36, 37].

1.1.41 Signalling System

The process by which cells interact with one another or with the outside world is known as cell signalling. Allosteric effects, chemical amplification, and feedback loops are some of the control mechanisms used by these complex chemical networks. Cell signalling occurs *via* a number of different mechanisms. Cell signalling is necessary in multicellular organisms to

control several processes. Both intracellular and intercellular cell signalling are possible. The same cells that receive an intracellular signal also create it. Signals between cells circulate throughout the body. This makes it possible for particular glands to provide signals that affect several tissues [38, 39].

1.1.42 Tissue Engineering

Tissue engineering involves the application of engineering principles and life sciences to develop biological substitutes that restore, maintain, or improve tissue function.

1.1.43 Xenograft, Xenotransplantation

Xenograft involves the transplant of tissue or organ in which the recipient is a member of a different species and the donor is a member of another animal species.

Xenotransplantation or heterologous transplant is the process of transferring living cells, tissues, or organs from one species to another [41].

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