BOTM: March 2008

Alginates

Alginates are naturally derived polysaccharides that are isolated from seaweed. The alginate molecule is comprised of (1-4)-linked b-D-mannuronic acid (M) and a-L-guluronic acid (G) monomers that vary in amount and sequential distribution along the polymer chain. Alginate is also considered a block copolymer, composed of sequential M units (M blocks), regions of sequential G units (G blocks), and regions of alternating M and G units (M-G blocks) that provide the molecule with its unique properties. Alginates have the ability to bind divalent cations such as Ca^{+2} between the G blocks of adjacent alginate chains, creating ionic interchain bridges between flexible regions of M blocks and causing shape-stable hydrogels out of solublized alginate molecules.

Alginate's gentle and cell friendly mechanism of gelation has led to extensive use in medicine, including cell therapy and tissue engineering applications. Alginates have been used since the 1940s as dental impression materials, microcapsules have been utilized since the late 70s as an encapsulation matrix for Islets, and more recently they have been used as an injectable cell delivery material.

Microcapsules containing cells are simply made by dissolving alginate in a cell-friendly buffer or culture medium and then mixing cells into this solution. The alginate/cell solution is then dropped or sprayed into a $CaCl_2$ bath, where the alginate forms a gel around the encapsulated cells (Figure 1). Droplet size and shape may be controlled by the processing parameters, but cell viability must always be taken into account when optimizing this process. Alternatively, cells may be mixed with soluble alginates and a calcium source within a syringe, allowing the injection of cells within the alginate matrix in a minimally invasive fashion. Alternatively, calcium binding kinetics may be slowed to allow for time-controlled gelation, allowing cell/alginate solutions the ability to be injected before taking their final form. This strategy may be used to allow for injection molding of engineered tissues of specific shapes, or for the shape of the tissue to be dictated by the defect it is to fill.

The alginate molecule lends itself readily to covalent modification via the abundant carboxyl moieties available on each monomer. Covalent strategies have been used to modify alginates with cell signaling molecules such as peptides, extracellular matrix molecules, or growth factors. Alginates may also be covalently crosslinked using similar chemistries, providing greater control over the mechanical and chemical properties of the final hydrogel material.

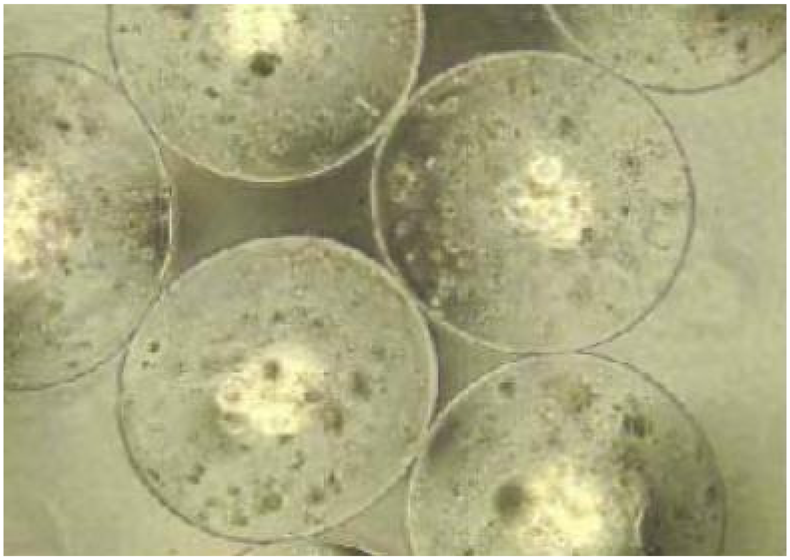

Figure 1.animal cells encapsulated within alginate microspheres. Borrowed from Novamatrix application memo, which can be found at novamatrix.biz