Cell Movements

Cell movements or motility is an active phenomenon that is essential for many biological processes such as morphogenesis, wound healing, immune response and even cancer metastasis. Here our focus is on morphogenetic processes where cell movement is targeted to specific sites in the developing embryo to form tissues and organs, A good example of these cell movement or cell migrations is seen in the movement of neural crest cells (multipotent cells that arise from embryonic ectoderm and give rise to different types of cells) and germ cells in vertebrates. Short range movements are also important and cell motility is responsible for both movements of individual cells as well as change of shape while remaining part of a tissue. For example, the folding of epidermal sheets to make tubes is caused by changes in the shape of the cells.

All cells move and change shape by rearranging their internal cellular skeleton (cytoskeleton) or scaffolding by contraction of the cytoskeleton fibres made up of microtubules and microfilaments that are actin – myosin complexes also termed as actomyosin complexes. These actomyosin complexes are simpler version of those seen in muscles. The energy required to produce the movement comes from adenosine triphosphate (ATP). In non-muscle cells these actomyosin complexes are concentrated in the region just below the cell membrane. Moving cells also have a polarity that is, a front and a back region. The mechanism of cell movement can best be seen in the movement or crawling of fibroblasts (a type of connective tissue that secretes collagen found in the extracellular matrix) on a substratum which is the extracellular matrix inside the embryo or glass surface of petri-plates under in vitro conditions (Fig.11.2). Fibroblasts extend a flat process called lamellipodium which is rich in microfilaments made up of a crisscross of actin. From the lamellipodium extend focal contacts that attach it to the substratum and these are connected to the microfilament bundles of the lamellipodium. During movement the microfilaments contract and the body of the cell is pulled forwards. Cells of the embryo essentially move in a similar manner. Instead of the large lamellipodium they may have multiple thin filopodia that make the contact with the extracellular matrix as they move over it.

In the embryo the cell movement is directional towards a signal which is a chemoattractant that is detected by the proteins on the cell membrane. These chemoattractants are diffusible molecules and the cells move towards increasing concentrations of the diffusible molecules.

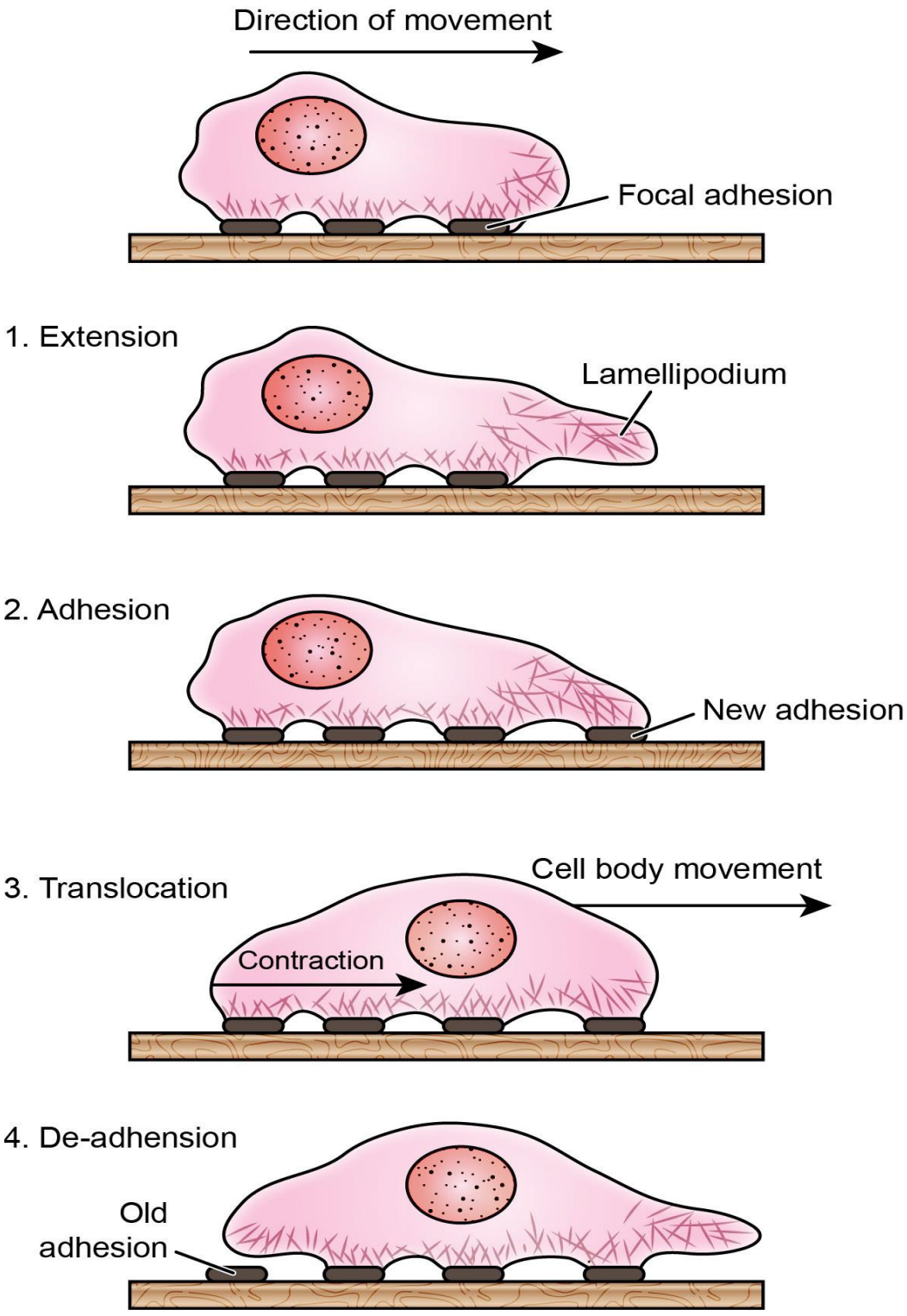

Fig.11.2: Fibroblast moves by extending the large flat lamellipodium that makes contact with the substratum.

Cell shape also changes by the contraction of microfilaments and the associated motor proteins actin and myosin. If the constriction happens in the apical region of epithelial cells it will reduce the apical surface area and elongate the cell (Fig.11.3). This happens initially during invagination during the process of gastrulation when the cells leave the epithelium to move inside the gastrula.

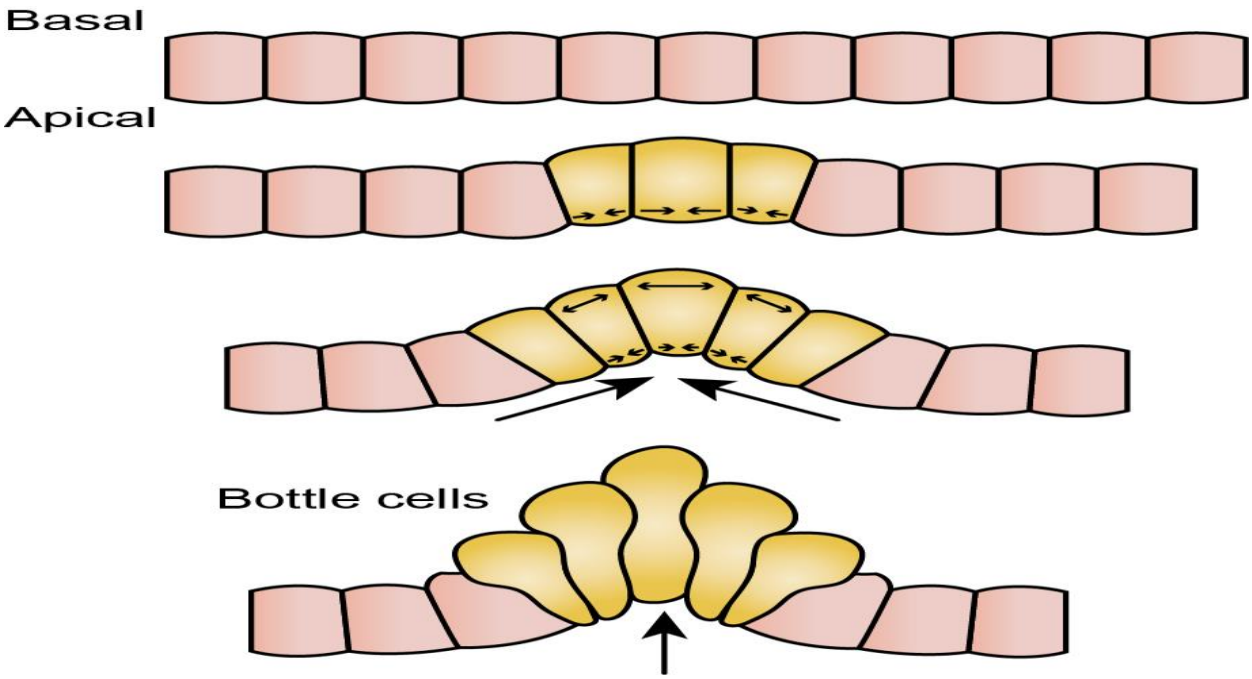

Fig. 11.3: Cell shape change in epithelial cells by apical constriction and result in elongation of the cell.