



Figure 1-12 Interactions of extracellular matrix (ECM) and growth factors mediated cell signaling. Cell surface integrins interact with the cytoskeleton at focal adhesion complexes (protein aggregates that include vinculin, α -actinin, and talin; see Fig. 1-16C). This can initiate the production of intracellular messengers or can directly transduce signals to the nucleus. Cell surface receptors for growth factors can activate signal transduction pathways that overlap with those mediated through integrins. Signals from ECM components and growth factors can be integrated by the cells to produce a given response, including changes in proliferation, locomotion, and/or differentiation.

underlying connective tissue; it does not just provide support to the epithelium but is also functional. For example, in the kidney, it forms part of the filtration apparatus.

The ECM is constantly being remodeled; its synthesis and degradation accompany morphogenesis, tissue regeneration and repair, chronic fibrosis, and tumor invasion and metastasis. The appreciation of the structure and functions of the ECM has led to many recent attempts to create “artificial organs” by growing epithelia on various ECM substrates. This is a potential approach for replacing damaged tissues and organs.

ECM occurs in two basic forms: interstitial matrix and basement membrane (Fig. 1-13).

- *Interstitial matrix* is present in the spaces between cells in connective tissue, and between parenchymal epithelium and the underlying supportive vascular and smooth muscle structures. Interstitial matrix is synthesized by mesenchymal cells (e.g., fibroblasts),

forming a three-dimensional, relatively amorphous gel. Its major constituents are fibrillar and nonfibrillar collagens, as well as fibronectin, elastin, proteoglycans, hyaluronate, and other constituents (see later).

- *Basement membrane.* The seemingly random array of interstitial matrix in connective tissues becomes highly organized around epithelial cells, endothelial cells, and smooth muscle cells, forming the specialized basement membrane. The basement membrane is synthesized by contributions from the overlying epithelium and underlying mesenchymal cells, forming a flat lamellar “chicken wire” mesh (although labeled as a *membrane*, it is quite porous). The major constituents are amorphous nonfibrillar type IV collagen and laminin.

Components of the Extracellular Matrix. The components of ECM fall into three groups of proteins (Fig. 1-14):

- *Fibrous structural proteins* such as collagens and elastins that confer tensile strength and recoil