signaling cascades after the signal binds. A large number of these receptors have been identified and are grouped into three families defined by the mechanism used to transduce signal binding into a cellular response:

- Membrane-impermeant signaling molecules can bind to and activate either (a) channel-linked receptors, (b) enzyme-linked receptors, or (c) G-protein–coupled receptors. Membrane-permeant signaling molecules activate intracellularly.
- Channel-linked receptors (also called ligand-gated ion channels) have the receptor and transducing functions as part of the same protein molecule. Interaction of the chemical signal with the binding site of the receptor causes the opening or the closing of an ion channel pore in another part of the same molecule. The resulting ion flux changes the membrane potential of the target cell and, in some cases, can also lead to the entry of Ca^{2+} ions that serve as a second messenger signal within the cell.
- Enzyme-linked receptors also have an extracellular binding site for chemical signals. The intracellular domain of such receptors is an enzyme whose catalytic activity is regulated by the binding of an extracellular signal. A great majority of these receptors are protein kinases, often tyrosine kinases, that target phosphorylate intracellular proteins, thereby changing the physiological function of the target cells. Noteworthy members of this group of receptors include the Trk family of neurotrophin receptors and other receptors for growth factors.
- G-protein–coupled receptors regulate intracellular reactions by an indirect mechanism involving an intermediate transducing molecule, called the GTP-binding proteins (or G-proteins). Because these receptors all share the structural feature of crossing the plasma membrane seven times, they are also referred to as 7-transmembrane receptors.

Intracellular receptors are activated by cell-permeant or lipophilic signaling molecules. Many of these receptors lead to the activation of signaling cascades that produce new mRNA and protein within the target cell. Often such receptors comprise a receptor protein bound to an inhibitory protein complex. When the signaling molecule binds to the receptor, the inhibitory complex dissociates to expose a DNA-binding domain on the receptor. This activated form of the receptor can then move into the nucleus and directly interact with nuclear DNA, resulting in altered transcription. Some intracellular receptors are primarily located in the cytoplasm, while others are in the nucleus. In either case, once these receptors are activated, they can affect gene expression by altering the DNA transcription.

For products like GCSF, interferon, and granulocyte macrophage colony–stimulating factor, proliferation assays are used; for mAbs, the assay will depend on the MOA (Table 4.5).