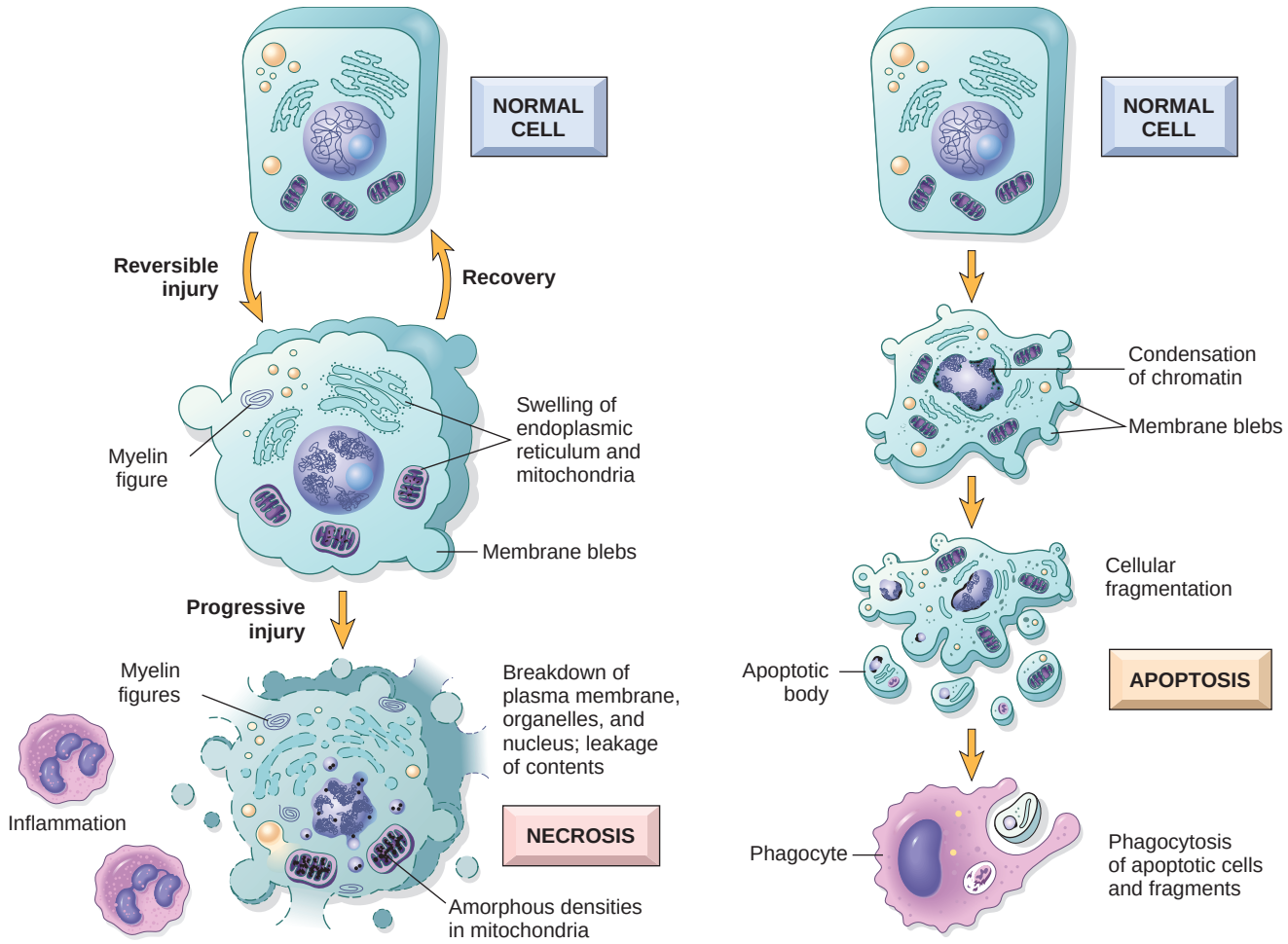

Figure 2-8 Schematic illustration of the morphologic changes in cell injury culminating in necrosis or apoptosis.

MORPHOLOGY

Cellular swelling is the first manifestation of almost all forms of injury to cells (Fig. 2-9*B*). It is a difficult morphologic change to appreciate with the light microscope; it may be more apparent at the level of the whole organ. When it affects many cells, it causes some pallor, increased turgor, and increase in weight of the organ. On microscopic examination, small clear vacuoles may be seen within the cytoplasm; these represent distended and pinched-off segments of the ER. This pattern of nonlethal injury is sometimes called **hydropic change** or **vacuolar degeneration**. Swelling of cells is reversible. Cells may also show increased eosinophilic staining, which becomes much more pronounced with progression to necrosis (described later).

The ultrastructural changes of reversible cell injury (Fig. 2-10*B*) include:

1. **Plasma membrane alterations,** such as blebbing, blunting, and loss of microvilli
2. **Mitochondrial changes,** including swelling and the appearance of small amorphous densities
3. **Dilation** of the **ER,** with detachment of polysomes; intracytoplasmic myelin figures may be present (see later)
4. **Nuclear alterations,** with disaggregation of granular and fibrillar elements

Necrosis

The morphologic appearance of necrosis as well as necroptosis is the result of denaturation of intracellular proteins and enzymatic digestion of the lethally injured cell. Necrotic cells are unable to maintain membrane integrity and their contents often leak out, a process that may elicit inflammation in the surrounding tissue. The enzymes that digest the necrotic cell are derived from the lysosomes of the dying cells themselves and from the lysosomes of leukocytes that are called in as part of the inflammatory reaction. Digestion of cellular contents and the host response may take hours to develop, and so there would be no detectable changes in cells if, for example, a myocardial infarct caused sudden death. The earliest histologic evidence of myocardial necrosis does not become apparent until 4 to 12 hours later. However, because of the loss of plasma membrane integrity, cardiac-specific enzymes and proteins are rapidly released from necrotic muscle and can be detected in the blood as early as 2 hours after myocardial cell necrosis (Chapter 12).