While studies have been performed to evaluate the toughening of bioactive glass scaffolds, these studies have been performed on scaffolds with a low strength. It is necessary to evaluate the toughening of bioactive scaffolds with far higher strength (e.g., compressive strength of 100–150 MPa, comparable to the values for cortical bone), for applications in the repair of load-bearing bone defects.

15.5 BIOLOGICAL PERFORMANCE

The in vitro and in vivo responses of bioactive glass scaffolds are dependent primarily on the glass composition and the pore architecture (microstructure) of the scaffolds. The ability of bioactive glass scaffolds to support cell proliferation and function in vitro and tissue ingrowth in vivo has been shown in numerous studies (Fu et al., 2008c, 2010c,e; Goodridge et al., 2007; Itala et al., 2003; Lee et al., 2006; Yuan et al., 2001; Zhao et al., 2008). Fu et al. showed that 13–93 bioactive glass scaffolds prepared using a polymer foam replication method supported the attachment and proliferation of MC3T3-E1 pre-osteoblastic cells both on the surface and within the interior pores of the scaffold (Fig. 15.7A and B) (Fu et al., 2008c).

Animal models including dogs, rabbits, and rats have been used for the in vivo evaluation of bioactive glass scaffolds (Fu et al., 2010c,e; Goodridge et al., 2007; Itala et al., 2003; Lee et al., 2006; Yuan et al., 2001; Zhao et al., 2008).

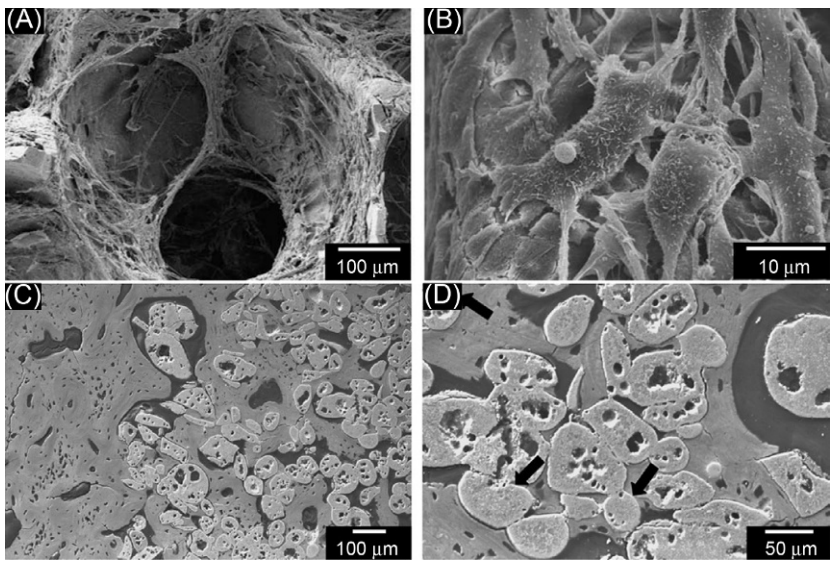

FIG. 15.7 Cell and bone ingrowth in bioactive glass scaffolds: (A) cell infiltration in bioactive 13–93 glass scaffolds; (B) detailed cell morphology on the scaffold (Fu et al., 2008c); (C) bone ingrowth in an apatite-mullite scaffold; (D) high magnification of (C) to show the direct contact of bone to a glass scaffold (Goodridge et al., 2007).