nondissolving and nonabsorptive matrix. The patch contains three extracts namely, *C. asiatica, Echinacea purpurea, and Sambucus nigra*. In vivo studies revealed a large number of proliferating cells at day 5 with numerous blood vessels at day 1. The patch is useful for accelerated healing of soft tissues after oral surgical procedures [115].

3.6. Nanofibers

Nanofibers exhibit morphology and structure that are similar to natural ECM making them systems that support cell growth (Fig. 7). They exhibit small diameters and a large surface area to volume ratio with high porosity. They can be loaded with bioactive agents. Nanofibers possess the following properties: antimicrobial activity, oxygen permeability, high porosity, cell adhesive properties, suitable mechanical properties, biodegradability, and wound-healing properties [116]. The incorporation of bioactive agents facilitates wound healing. Nanofibers size contributes to their intrinsic hemostatic activity which does not involve the use of hemostatic agents. They exhibit high swelling capability and can absorb large amount of wound exudates. Their high porosity provides a good exchange of gases and moisture with the air (Internet source: Wound dressing). Their highly porous structure mimics the skin ECM and can stimulate cells to infiltrate the scaffolds thereby inducing the formation of new skin and hindering scar formation. They are easily sterilized due to their highly porous structure (Internet source: Wound dressing). Nanofibers have been designed by some researchers for wound dressing (Table 4).

Kataria et al. prepared poly(vinyl alcohol)/sodium alginate electrospun composite nanofiber loaded with ciprofloxacin. In vivo studies on male rabbits revealed accelerated wound healing. In vitro drug release was sustained and controlled. Hydroxyproline produced in wound bed was maximum in the drug-loaded nanofiber [97]. Nitanan et al. prepared poly(styrene sulfonic acid-*co*-maleic acid) blended with poly(vinyl alcohol) by thermal cross-linking to produce PSSA-MA/PVA nanofiber mats. Neomycin, an antibiotic was loaded into the nanofibers. In vivo wound healing performed in Wistar rats revealed decreased wound size in the first week. The diameters of the fibers were 250 nm with 268% percentage water uptake. The drug-loaded nanofiber mats exhibited antibacterial activity against Gram-positive and Gram-negative bacteria [98]. Unnithan et al. prepared nanofibers from dextran and polyurethane followed by loading with ciprofloxacin HCl. The nanofibers displayed good bactericidal activity against Gram-negative and Gram-positive bacteria. In vitro studies revealed the interaction of fibroblasts with the nanofibers which further indicated the potential application of the nanofibers as wound dressings [99].

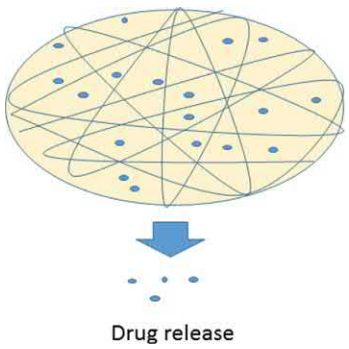

FIG. 7 Nanofibers loaded with antimicrobial agents.

Qi et al. fabricated nanofiber halloysite nanotubes/poly(lactic-*co*-glycolic acid) composite nanofibers (TCH/HNTs/PLGA) loaded with tetracycline. In vitro viability assay of the nanofiber in mouse fibroblast cells culture indicated the cytocompatibility of the nanofibers. The drug release was sustained for 42 days with good antimicrobial activity [100]. Alavarse et al. incorporated tetracycline hydrochloride into poly(vinyl alcohol)/chitosan nanofibers for wound dressing. The drug release was a burst delivery in the first 2 h resulting in an effective antibacterial activity on Gram-negative, *E. coli*, *Staphylococci epidermidis*, and *S. aureus*. The nanofibers also exhibited good cytocompatibility [101]. Soscia et al. loaded chloramphenicol into electrospun poly(lactic-*co*-glycolic acid) nanofibers. The nanofibers inhibited significantly the bacterial growth of the following strains of bacteria in vitro: *E. coli, B. cereus, and Salmonella typhimurium*. In vitro cytotoxicity of the drug-loaded nanofiber on mammalian cells, mouse embryonic stem cells and fibroblasts showed a high cell viability of more than 96% indicating minimal cytotoxicity [102]. Li et al. electrospun fiber mats containing poly[di(ethylene glycol) methyl ether methacrylate] and poly(L-lactic acid-*co*-ε-caprolactone) followed by the loading of ciprofloxacin. The thermosensitive properties of the nanofibers influenced the in vitro sustained release of ciprofloxacin over a period of 160 h. The nanofibers enhanced the proliferation of fibroblasts. Varying the temperature promoted cells attachment to the nanofiber. The drug-loaded nanofibers inhibited the growth of *E. coli* and *S. aureus*. In vivo investigations on rats showed regeneration of a thick uniform epidermis with the regularity of the epidermis similar to normal skin [103].