under ultraviolet (UV) irradiation through reductive chemical reaction. In the aforementioned system, HA exhibited cellular proliferation induction and migration roles while dextran improved skin regeneration and facilitated neovascularization [33, 34]. At the final stage, PEI/pDNA-VEGF complex and resveratrol were co-loaded in the prepared hydrogel. The obtained results verified the excellent characteristics of the prepared platform as a wound dressing [35].

Gelatin and dextran having biodegradability and biocompatibility properties were used as self-healing materials. Chlorhexidine acetate (CHA) acted as an antimicrobial agent. Beside, bFGF can promote angiogenesis, cell proliferation, migration, and tissue repair [36]. One of the barriers to using bFGF is its short half-life. In this regard, a sequential drug delivery system of CHA and bFGF was used to overcome this obstacle [37]. Hydrogel is a suitable dressing material with sequential release properties for wound healing. The hydrogel network was prepared by the dynamic reaction under physiological conditions (pH 7.4) implementing oxidized dextran (OD), aminated gelatin, and adipic acid dihydrazide. Encapsulation of bFGF in PLGA (poly(lactic-*co*-glycolic acid)) microspheres can control the release of bFGF from the hydrogels. After the application of bFGF@PLGA/CHA/hydrogel into the wound site, sequential delivery of bFGF and CHA and thus acceleration of wound-healing process occurred [38].

In another attempt, Du et al. applied a hydrogel dressing with self-healing, antibacterial, and hemostasis activity. Chitosan and OD were used to produce the composite hydrogel. In this regard, positively charged chitosan interacted with negatively charged bacterial membrane leading to the leakage of cellular proteins and other cellular components. Besides, hydrophobically modified chitosan (hmCS) has hemostatic and antibacterial activity. Aldehyde groups of OD interacted with the hmCS to obtain hydrogels with great potential as a wound dressing [25].

Zheng et al. designed a hydrogel based on poly(vinyl alcohol) and dextran-aldehyde which were cross-linked using freeze-thaw and freeze-drying method. The porous structure of hydrogel was uniform with 5–10-μm pore size. The prepared hydrogel accelerated the time frame of skin regeneration.

Silver nanoparticles (AgNPs) are effective antimicrobials agents. On AgNPs aggregation, the release of silver ions would decrease, thereby reducing the antimicrobial activity of AgNPs. To overcome this problem, the antifouling hybrid hydrogel consisted of cationic-thiolated chitosan and anionic maleic acid-grafted dextran was used to incorporate AgNPs and provide release of silver ions.

As a result, the expression of $CD68^+$ and $CD3^+$ increased leading to improved wound-healing process. The prepared AgNPs-loaded hydrogel introduces an excellent candidate for the treatment of diabetic ulcers [36].

In another study, poly(vinyl alcohol) (PVA)/dextran/chitosan hydrogel was applied for the preparation of a novel wound dressing. In this hydrogel, dextran reacted with PVA using glutaraldehyde (GA) as the cross-linker to improve angiogenic responses and regeneration of skin during burn wound-healing process. In this regard, chitosan, dextran, and PVA have also positive impact on antimicrobial, angiogenesis, and cell proliferation properties of this hydrogel [39].

Li and coworkers applied the block copolymer, DA95B5, consisted of dextran-block-poly((3–4 acrylamidopropyl) trimethylammonium chloride-*co*-butyl methacrylate), to remove biofilms of various multidrug-resistant Gram-positive bacteria. DA95B5 was self-assembled to form core-shell nanoparticles with cationic core and dextran shell. Dextran shell increased solubility of the bacteria-nanoparticle complex and thus decreasing the biofilm formation. The removal of biofilm occurred by weakening the bacterial attachment. This hydrogel was used to combat against multidrug-resistant Gram-positive bacteria producing biofilms [40].

In another study, a hydrogel composed of dextran-poly(ethylene glycol) (PEG) was prepared.

In the structure of this hydrogel, a thiol group of each antibiotic including polymyxin B and vancomycin (Vanco) was conjugated to the hydrogel network to provide a versatile antibacterial wound dressing against Gram-positive and Gram-negative bacteria [41].

### 3.2. Collagen

Collagen is a bioactive polymer extracted from skin, tendons, bones, ligaments animal cells, and forms 30% of the total protein in the body [42].

Due to its well-known structure, biocompatibility, hemostasis ability, bioresorbability, and reduced manufacturing cost properties, collagen is abundantly used as drug release support [43–49]. However, resistance to in vivo enzymatic degradation and its mechanical properties limited the application of collagen. To overcome the aforementioned obstacles, various strategies for its conjugation with other biopolymers or various cross-linkers were used [50, 51]. In this regard, matrices, hydrogels, fibers, and membranes are among various forms of collagen [52–56]. The porous form (spongious matrices) of collagen is capable of absorbing large amounts of wounds exudate and preserving a moist environment for wound healing. As a result, spongious matrices of collagen loaded with antiinflammatory drug, can