What is claimed:

1. A cell culture matrix comprising:

a multilayer substrate, each substrate layer of the multilayer substrate comprising a first side, a second side opposite the first side, a thickness separating the first side and the second side, and a plurality of openings formed in the substrate layer and passing through the thickness of the substrate layer,

wherein the plurality of openings is configured to allow flow of at least one of cell culture media, cells, or cell products through the thickness of the substrate layer.

2. The cell culture matrix of claim 1, wherein the multilayer substrate comprises at least one of polystyrene, polyethylene terephthalate, polycarbonate, polyvinylpyrrolidone, polybutadiene, polyvinylchloride, polyethylene oxide, polypyrroles, and polypropylene oxide.

3. The cell culture matrix of claim 1 or claim 2, wherein the multilayer substrate comprises at least one of a molded polymer lattice sheet, a 3D-printed lattice sheet, and a woven mesh sheet.

4. The cell culture matrix of claim 3, wherein the multilayer substrate comprises the woven mesh comprising one or more fibers.

5. The cell culture matrix of claim 4, wherein the one or more fibers comprises a fiber diameter from about 50 µm to about 1000 µm, from about 50 µm to about 600 µm, from about 50 µm to about 400 µm, from about 100 µm to about 325 µm, or from about 150 µm to about 275 µm, and

wherein the plurality of openings comprises an opening diameter of from about 100 µm to about 1000 µm, from about 200 µm to about 900 µm, or from about 225 µm to about 800 µm.

6. The cell culture matrix of any of claims 1-5, wherein the plurality of openings is arrayed in a regular pattern.

7. The cell culture matrix of any of claims 1-6, wherein the multilayer substrate comprises at least a first substrate layer and a second substrate layer, and

wherein the first substrate layer has a predetermined alignment with respect to the second substrate layer.

8. The cell culture matrix of any of claims 1-7, wherein the multilayer substrate comprises a plurality of substrate layers in a stacked arrangement.

9. The cell culture matrix of any of claims 1-8, wherein the multilayer substrate comprises a plurality of substrate layers that comprises woven meshes of differing geometries, wherein the differing geometries are different in at least one of fiber diameter, opening diameter, or opening geometry.

10. The cell culture matrix of claim 9, wherein the woven meshes of differing geometries are ordered in a predetermined arrangement based on desired flow characteristics within the bioreactor vessel.

11. The cell culture matrix of any of claims 1-10, wherein the cell culture matrix is configured for culturing and/or harvesting at least one of cells, proteins, antibodies, viruses, viral vectors, virus-like particles (VLPs), microvessicles, exosomes, and polysaccharides.

12. The cell culture matrix of any of claims 1-11, wherein the multilayer substrate comprises a functionalized surface, the functionalized surface being physically or chemically modified for improved adhesion of the adherent cells to the polymer mesh material.

13. The cell culture matrix of any of claims 1-12, wherein the cell culture matrix comprises a coating on a surface of the polymer mesh material, the coating being configured to promote adherence of the adherent cells.

14. The cell culture matrix of claim 13, wherein the coating is at least one of a hydrogel, collagen, Matrigel®, a bioactive molecule or peptide, and a biological protein.

15. The cell culture matrix of claim 13, wherein the functionalized surface is plasma treated.