Perivascular Cells

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Perivascular cells

Vascular Anatomy

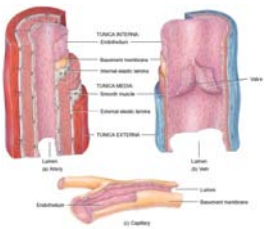
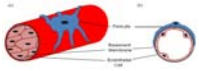


Image Courtesy of John Wiley & Sons

- The walls of all blood vessels, except capillaries, consists of three layers named *tunica intima*, *tunica media* and *tunica adventitia (tunica externa)*.
- The latter contain fibroblasts, collagen and nerves.
- Blood vessels are formed early on during embryogenesis from the mesoderm in a process known as *vasculogenesis*.
- Pericytes surround the endothelium as part of the basement membrane.



Mills, S. J., A. J. Cowin, and P. Kaur. "Pericytes, Mesenchymal Stem Cells and the Wound Healing Process." *Cells* 2, no. 3 (2013): 621–34.

Pericytes

- Pericytes have stem cell-like properties and are seemingly able to differentiate into adipocytes, chondrocytes, osteoblasts and granulocytes, leading them to be identified as mesenchymal stem cells (MSCs).
- They increase ECs proliferation/survival and migration.
- They release a large variety of GFs and cytokines.
- They may accelerate wound healing.
- There are several markers, none unique, and vary with location and time.

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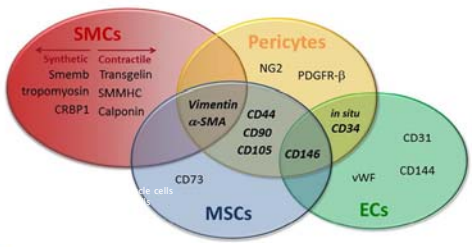
Marker Expression

Table 1
Comparison of marker expression between mesenchymal stem cells (MSCs), vascular smooth muscle cells (SMCs), pericytes and endothelial cells (ECs).

Cell type	Source	Phenotype	References
MSCs	Bone marrow, adipose tissue, peripheral blood, other tissues	CD44 +/CD90 +/CD105 +/CD73 +/CD146 +/CD34 −/CD45 −/CD14 −	Han et al. (2011)
SMCs	Arteries, veins	Synthetic: vimentin +/Smemb +/tropomyosin +/CRBP1 + Contractile: α-SMA +/Transgelin +/SMMHC +	Wanjare, Kuuma, and Genetti (2014)
Pericytes and pericyte-associated cells	Capillaries/microvessels from various tissues	NG2 +/PDGFRβ +/vimentin + CD146 + or −/CD34 + or − CD44 +/CD90 +/CD105 +/CD73 +/CD11 −/CD45 −/CD56 −	Campagnolo et al. (2010) Chen et al., (2015) Avolio, Meloni, et al. (2015)
ECs	Vascular intima	CD31 +/CD144 +/vWF +/CD34 +/CD45 −	Bompais et al. (2004)

Avolio, E., V. V. Alvino, M. T. Ghorbel, and P. Campagnolo. "Perivascular Cells and Tissue Engineering: Current Applications and Untapped Potential." *Pharmacology & Therapeutics* 171 (Mar 2017): 83-92.

Expressed Markers & Overlap



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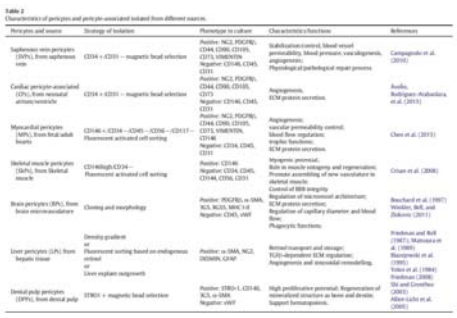

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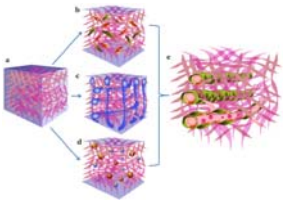
Strategies for Vascularization



a) Uniform vascularization.
b) Combination of the material with cells able to support angiogenesis.
c) Design of the scaffold structure reproducing vascular like-structures that will act as a guide for the angiogenic process.
d) Incorporation of angiogenic factors during the manufacture of the graft.
e) The result should be a vascularized graft in which new-formed vessels are mature and functionally competent.

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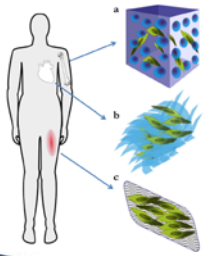
Perivascular Cells for Damaged Tissues



a) Bone reconstruction was achieved by incorporating PCs in 3D scaffolds.
b) Heart patches obtained by stacking multilayers of PCs combined grown on matrix substrate were devised for myocardial infarction.
c) Topical application of dermal patches containing PCs improved skin wound healing.

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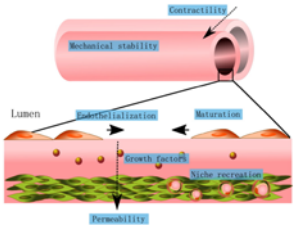
Role of Perivascular Cells in TE Grafts

1. The seeding of vascular grafts with perivascular cells increases their contractility and mechanical properties, regulating permeability.
2. The release of growth factors by the perivascular cells regulates endothelialization and endothelial cell function.
3. Additionally, perivascular cells contribute to the reconstitution of the perivascular niche, favoring the long-term graft success.



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Summary

- Pericytes have stem cell-like properties and are mesenchymal stem cells.
- They promote vessel growth and stability.
- May in the future be useful for vascular graft repopulation, and skeletal and cardiac muscle grafts.
- May be an alternative to bone marrow mesenchymal stem cells (BMSCs) for bone regeneration.