

- Vessels:**
- (1) Intima : innermost. Endothelial cells. 80 nm thick. In direct contact with blood flow.
  - (2) Media: middle. Smooth muscle, Type III collagen, elastin layer. Responsible for temporal constriction/vasodilation of the vessels – often in response to pressure changes.  
Elastin: can undergo 80% strain
  - (3) Adventitia: fibroblasts, type III collagen

**Artery:**

(active)

> media layer → > smooth muscle

> elastin

**Veins:**

Mainly a conduit (passive)

> collagen/elastin ratio

Thicker adventitia

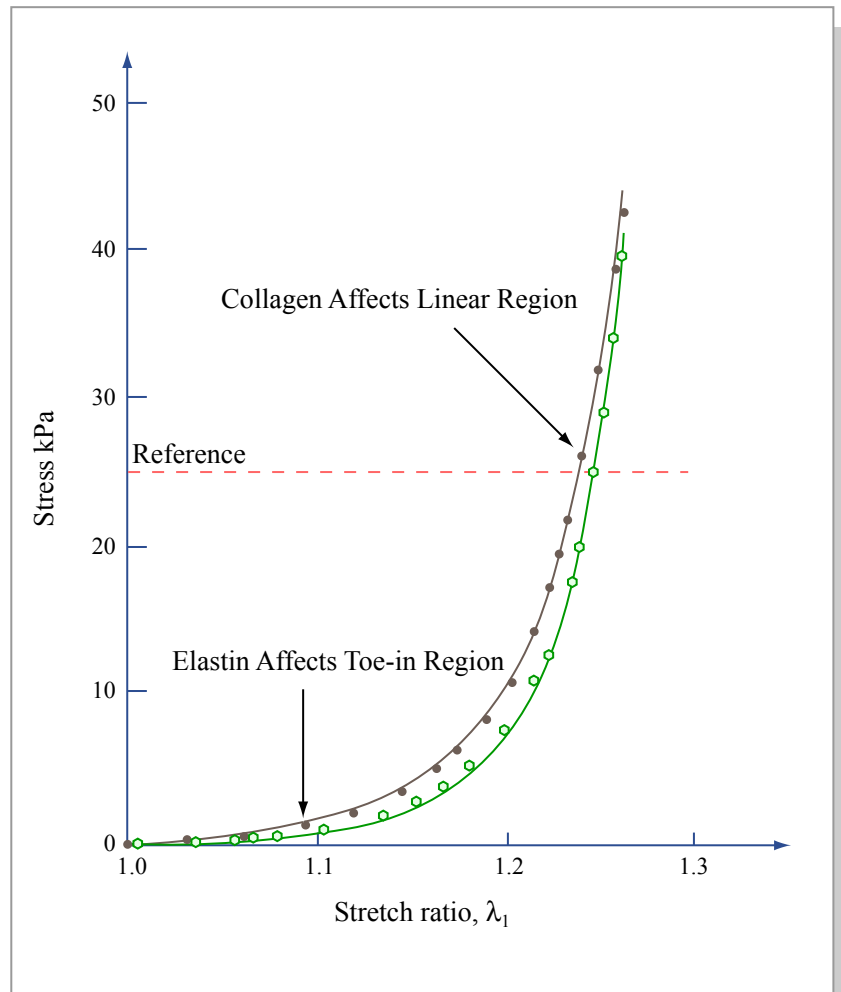


Figure by MIT OCW.

human vena cava

Digest out collagen w/trypsin

Digest out elastin w/formic acid

**Toe region:** collagen extends, carrying the load, ~uncoiling spring. Elastin is considered linearly elastic.

**Linear region:** collagen is straightened.

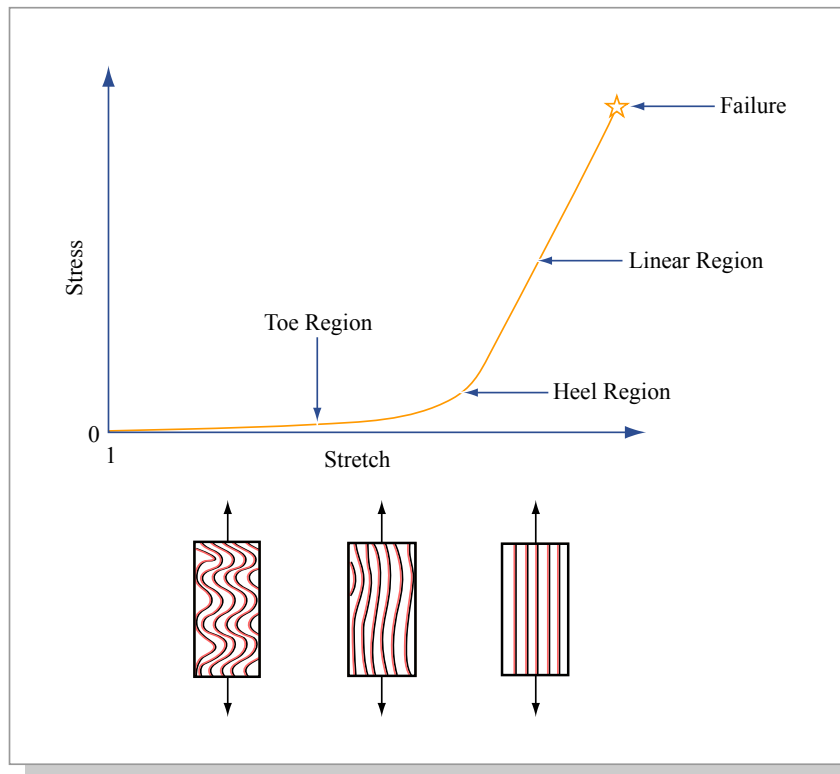


Figure by MIT OCW.

**Blood vessel adaptation:** changes in structure + number of vessels

Adapts the circulatory system to the needs of the tissue while controlling blood flow.

Shear stress is known to modulate gene expression and we know from mechanics that changes in pressure change the stress on the vessel wall.

**Shear stress sensors:** on the cell membrane, or transduced through the cytoskeleton to the nucleus.

High blood pressure raises mechanical load on blood vessel.

- How does this shift the stress-strain curve? (shift left → higher stresses for lower strains)

**Hypoxic chamber:** 2kPa → 2.93 kPa (minutes) → 4kPa (month) for systolic blood pressure

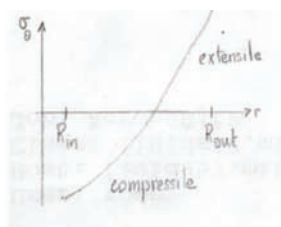
**Structural changes:** significant thickening of the media layer in the artery.

Another measure of vessel mechanical properties is angle of opening.

Residual stress = pre-stress

Used to balance the normal stress applied by the blood pressure, so vessel is in zero-stress condition when filled with blood.

Residual stress increases with greater pressure in the artery, then after prolonged exposure the opening angle is the same as before – indicating adaptation.



(d) Slicing of a vessel:

Since the inner regions are under compression and the outer regions under tension, a positive moment acts within the wall before this one is cut. After the cut is made, these moments are removed and the vessel will open up more.