

Coronary Microvasculature

Structure..... and function

26-04-2104

Dirk J. Duncker

Coronary Microvasculature

- Microvascular resistance
 - Longitudinal aspects
 - Transmural aspects
- Effects of a Coronary Artery Stenosis
 - Acute
 - chronic

Duncker & Bache *Pharm Ther* 2000

Duncker & Bache *Physiol Rev* 2008

Laughlin et al *Compr Physiol* 2012

Canty & Duncker *Braunwald's Heart Disease* 2014

Coronary Microvasculature

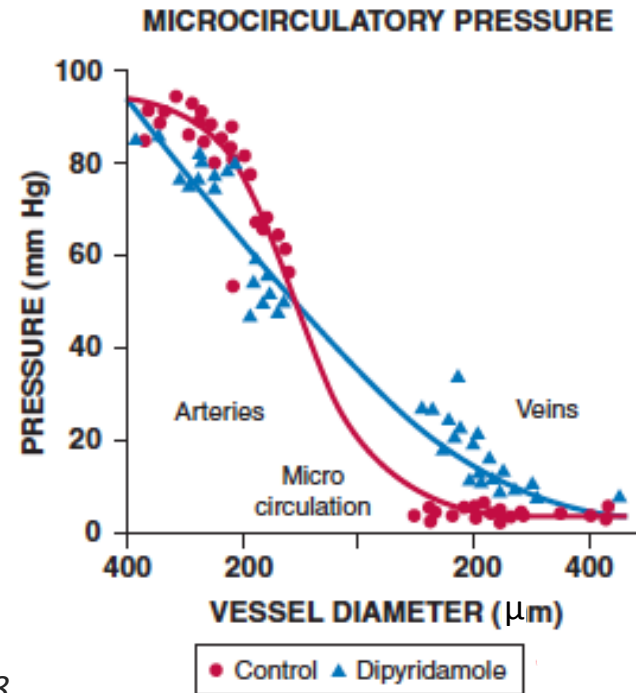
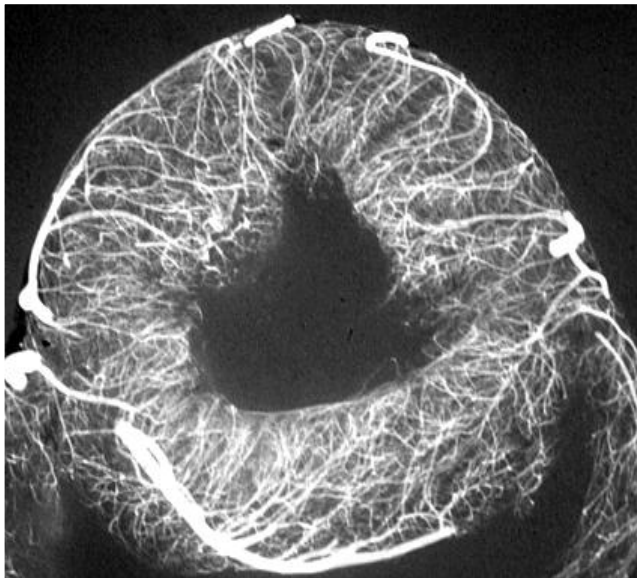
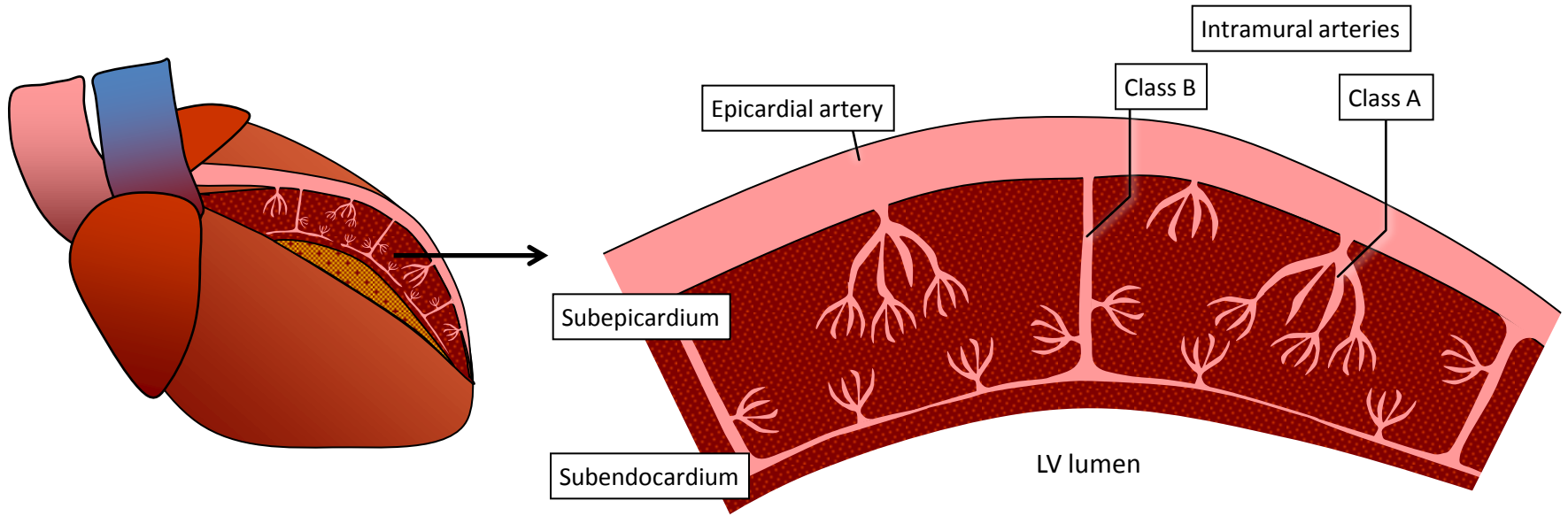
- *Distribution of microvascular resistance*
 - *Longitudinal aspects*
 - Transmural aspects
- Effects of a Coronary Artery Stenosis
 - Acute
 - chronic

Duncker & Bache *Pharm Ther* 2000

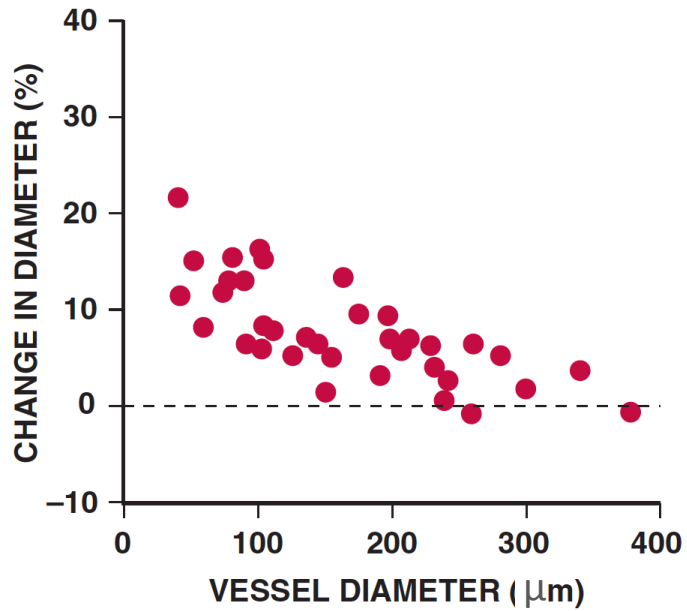
Duncker & Bache *Physiol Rev* 2008

Laughlin et al *Compr Physiol* 2012

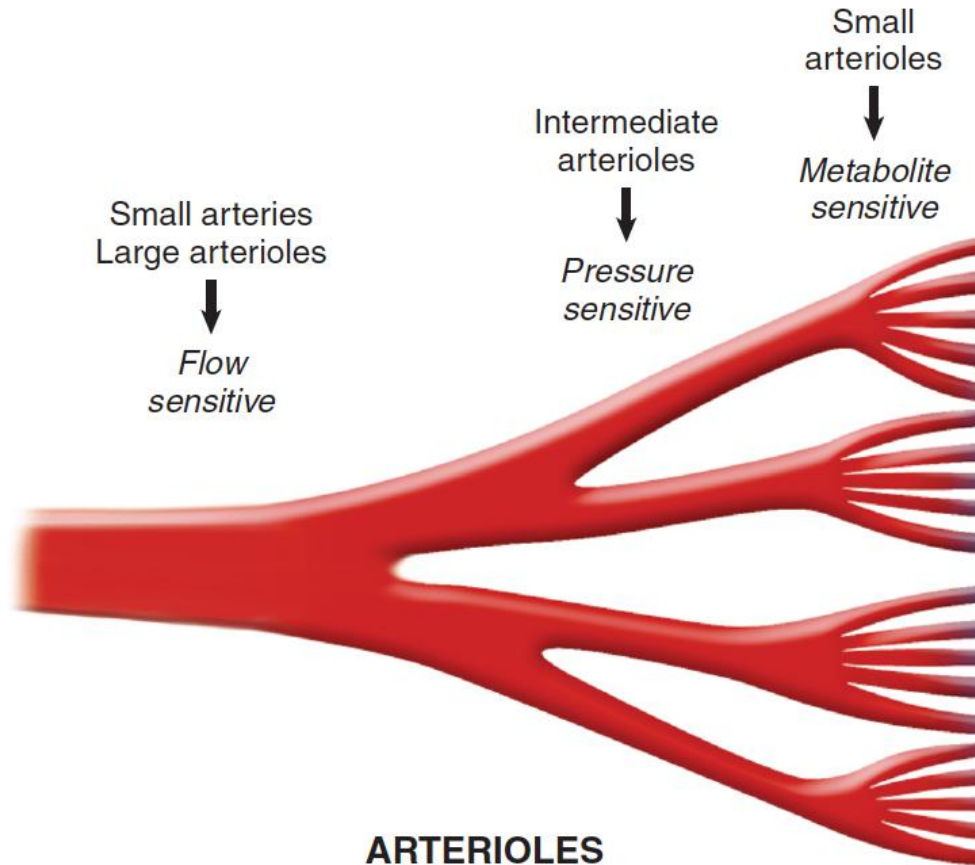
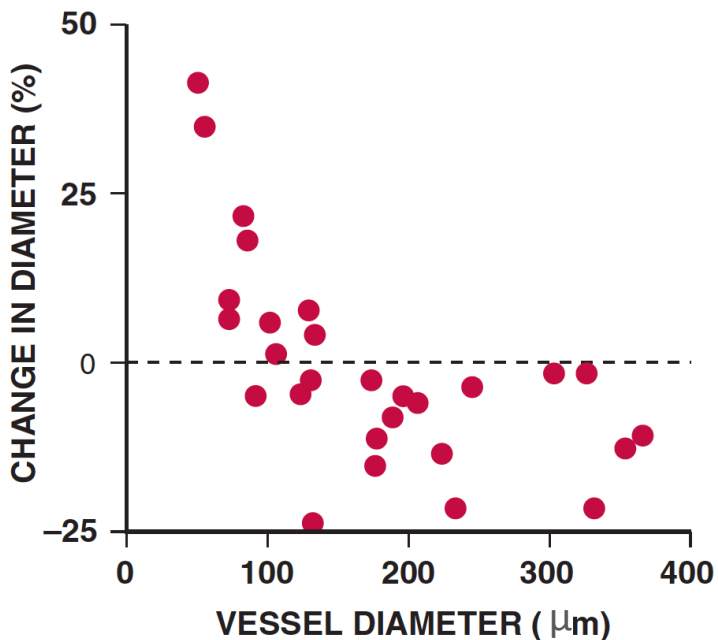
Canty & Duncker *Braunwald's Heart Disease* 2014



METABOLIC VASODILATION



AUTOREGULATION



Davis et al APS Handbook of Physiology 2008

Coronary Microvasculature

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 - ***Transmural aspects***
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 - Acute
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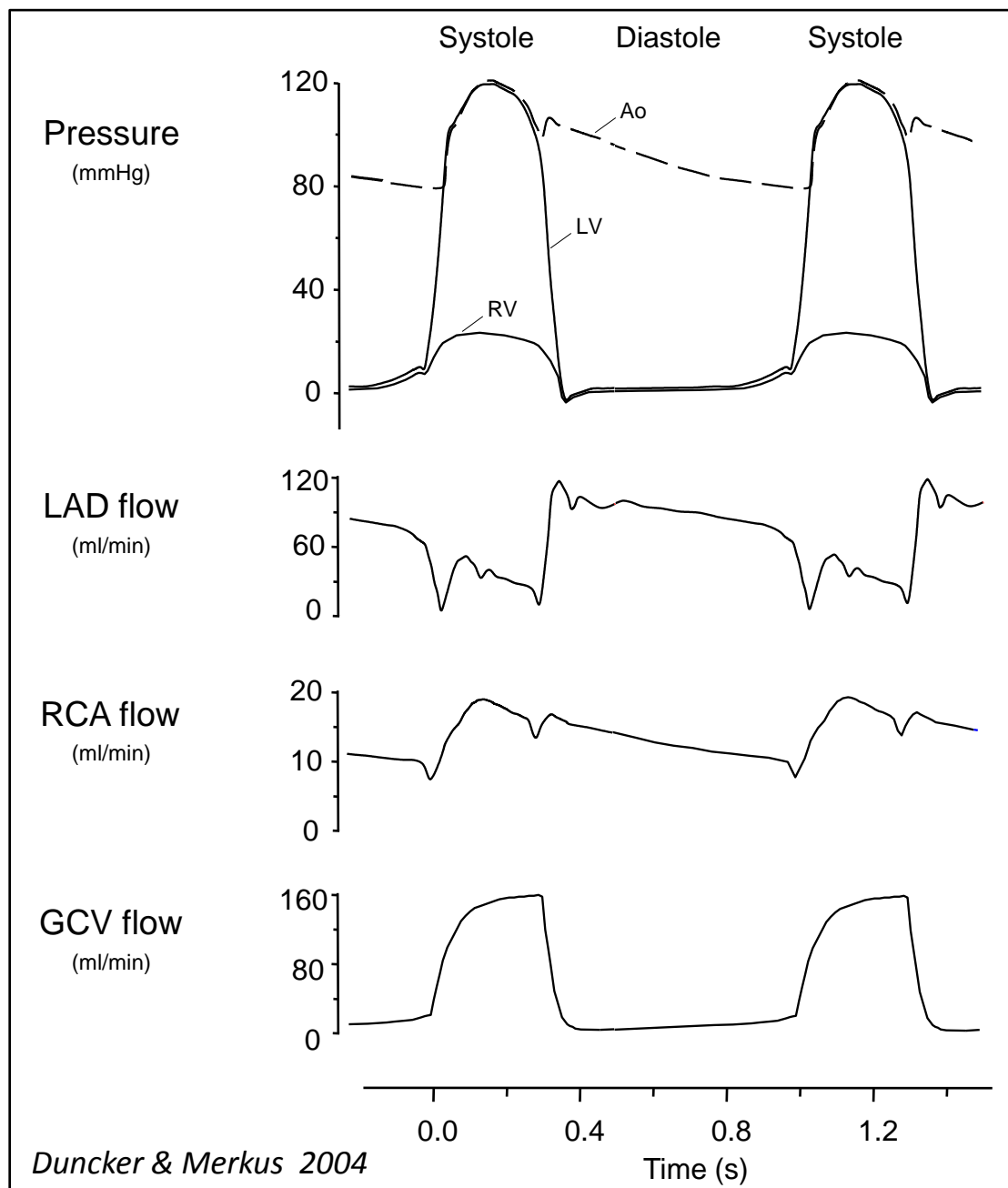
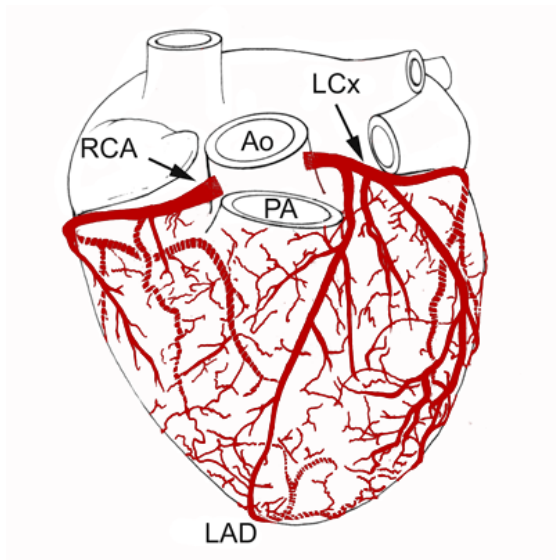
Duncker & Bache *Pharm Ther* 2000

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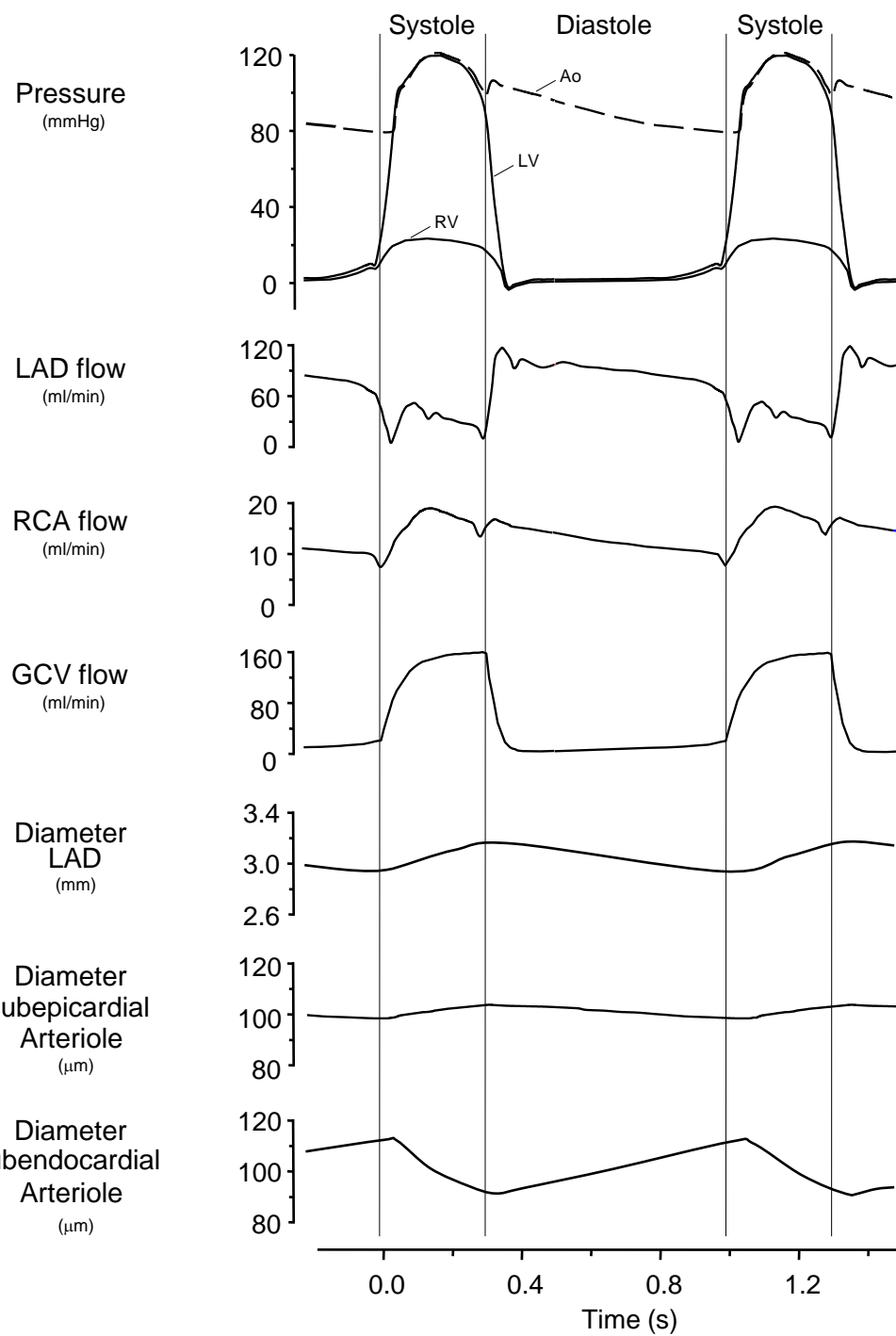
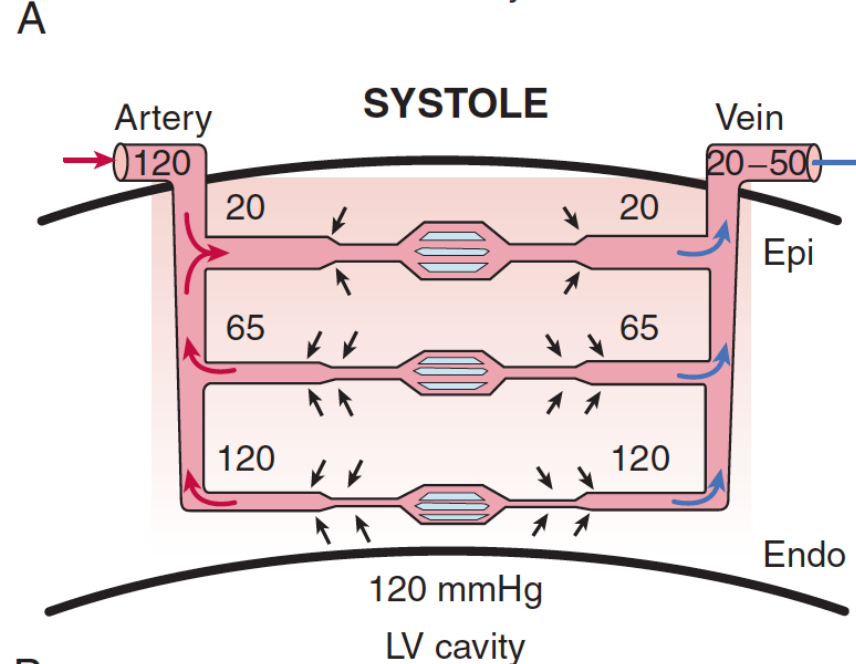
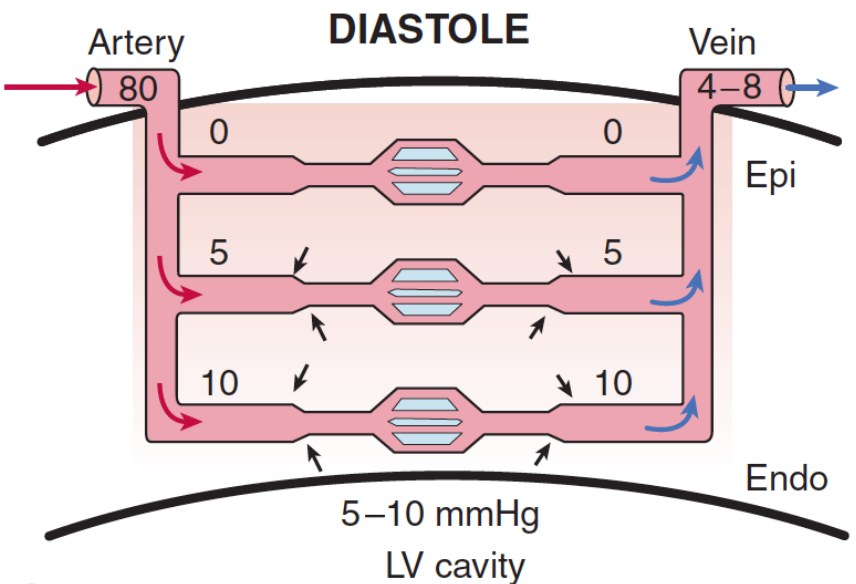
Canty & Duncker *Braunwald's Heart Disease* 2014

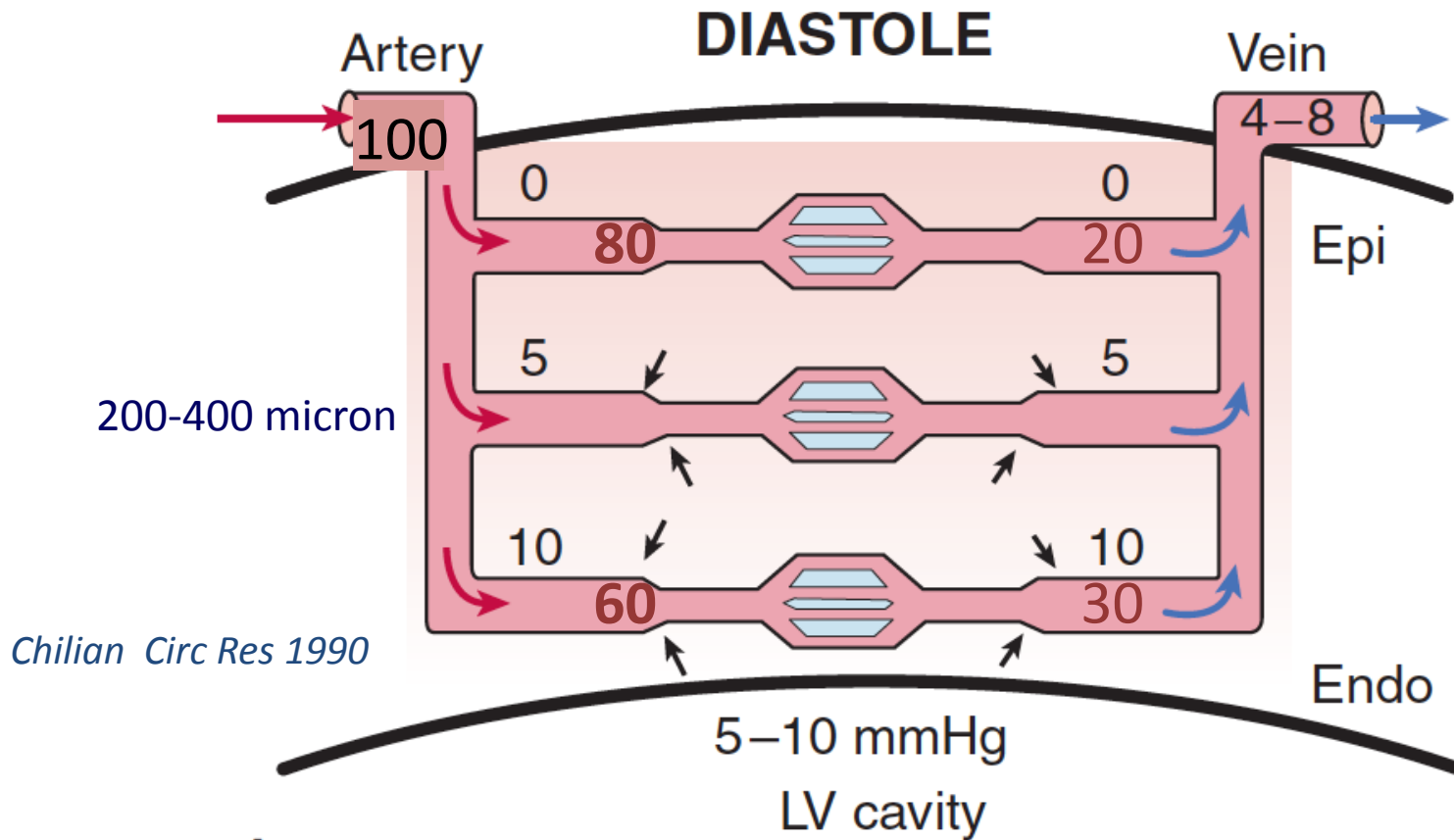
Cyclic Compression of the Coronary Microvasculature



Duncker & Merkus 2004

Intramyocardial Pump

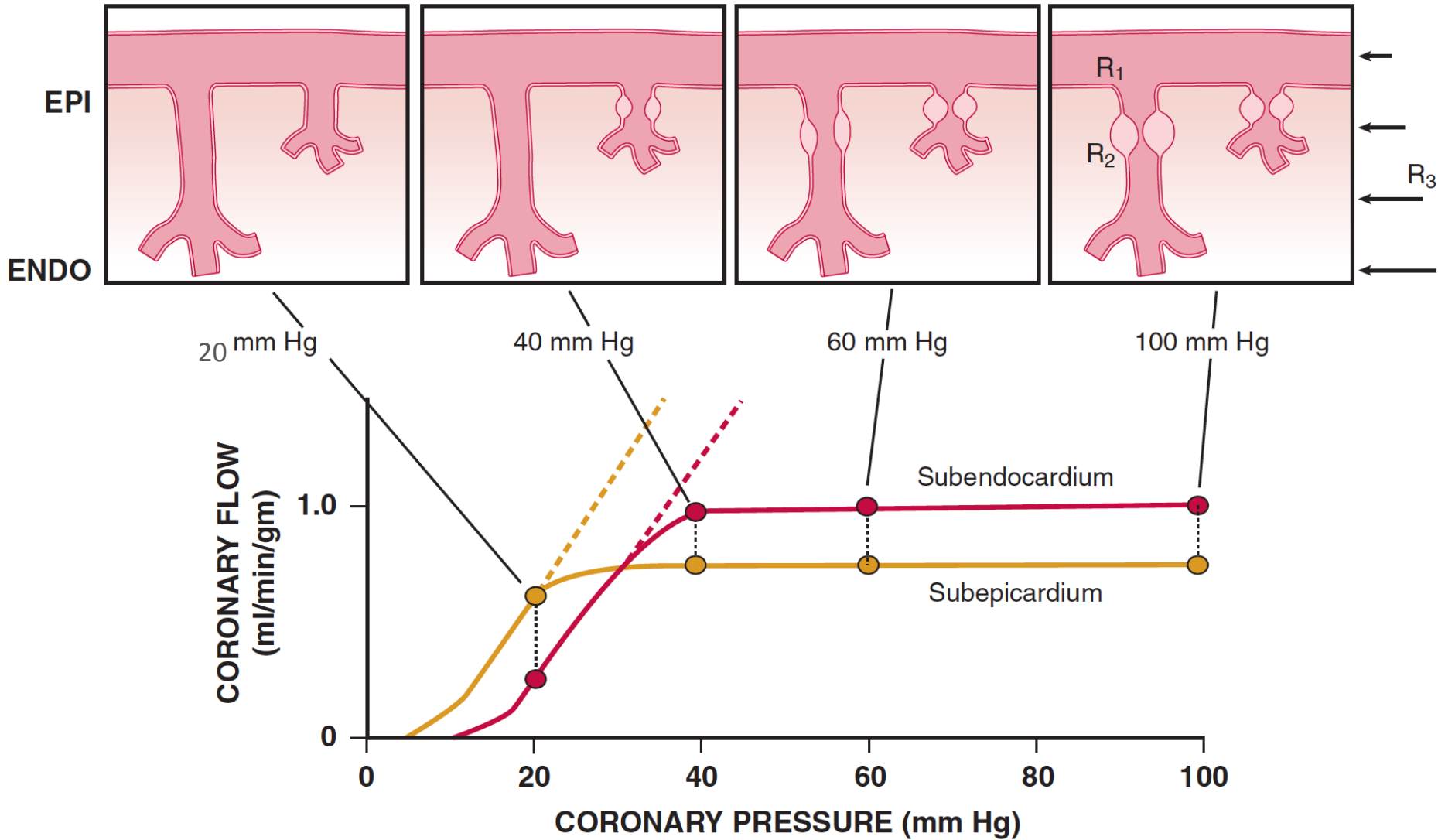




1. Compression greater in subendocardium
 2. Arteriolar pressure lower in subendocardium
- *~10% higher subendocardial vascular density*

Coronary Pressure-Flow Relation

Subendocardial Vulnerability



Coronary Microvasculature

- Microvascular resistance
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 - **Acute**
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Duncker & Bache *Pharm Ther* 2000

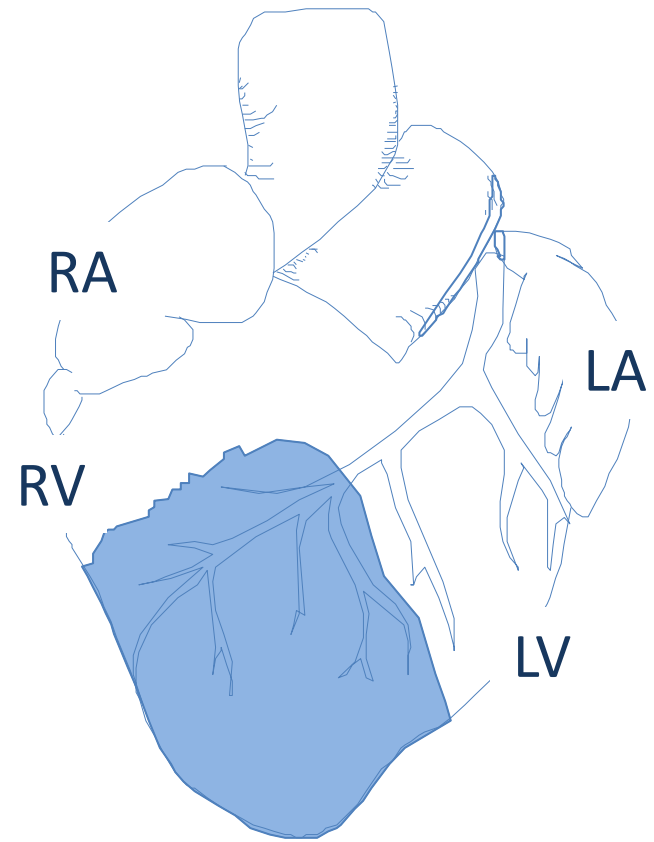
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Canty & Duncker *Braunwald's Heart Disease* 2014

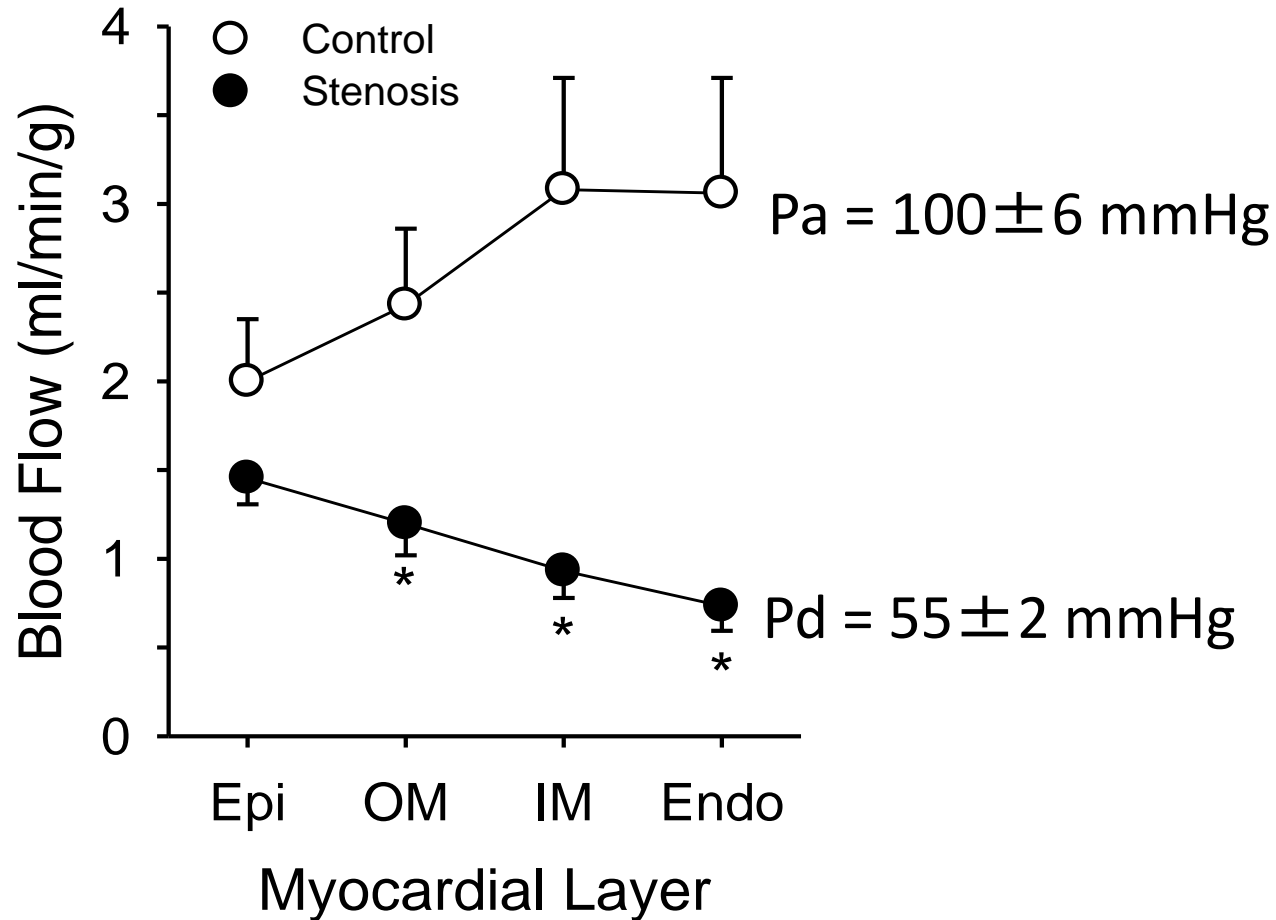
Acute Stenosis Model

- Dog
- Treadmill exercise at 200 bpm
- Inflatable balloon around LAD to maintain a constant distal coronary artery pressure of ~ 55 mmHg
- Myocardial blood flow measured with μ spheres



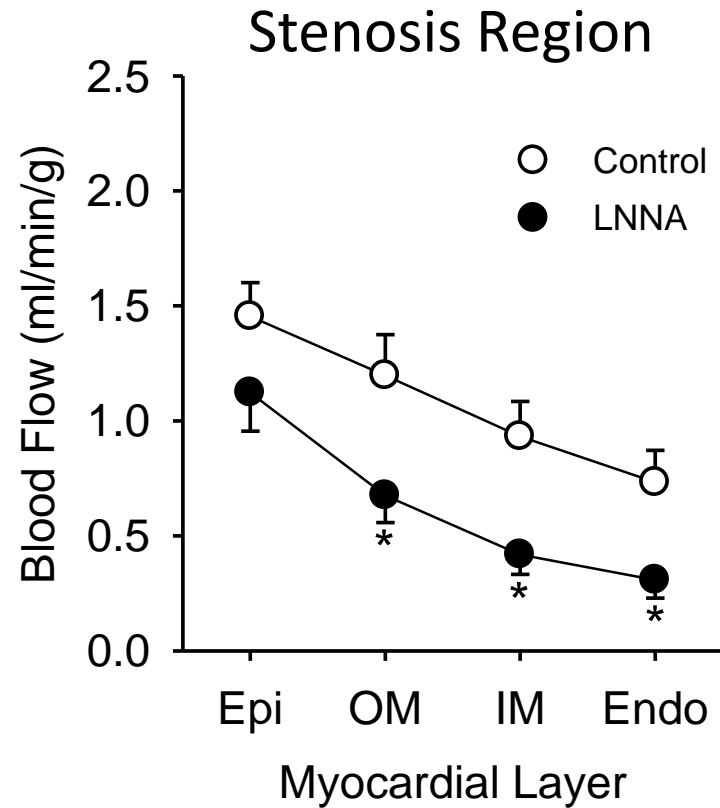
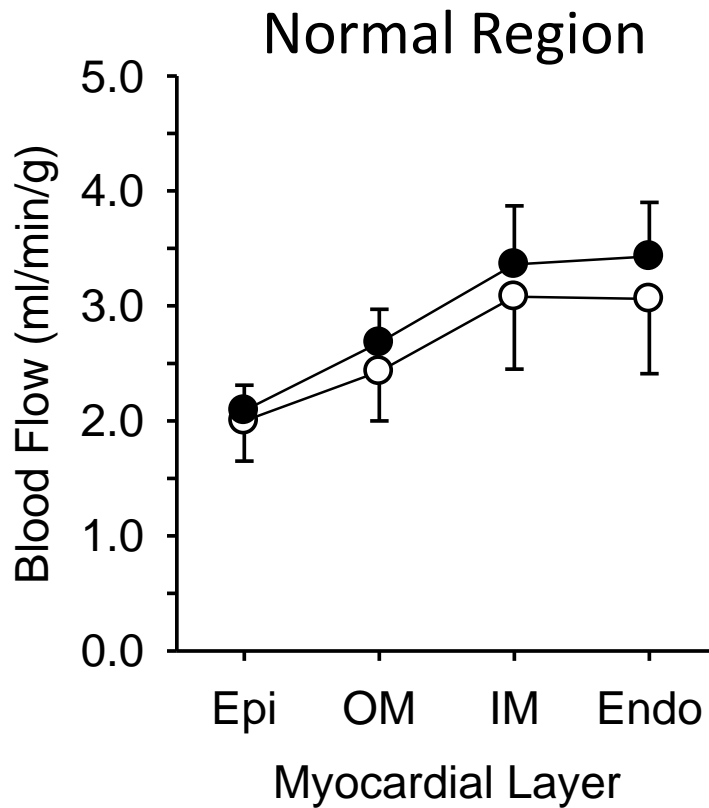
Myocardial blood flow during exercise

Effect of reduced coronary artery pressure



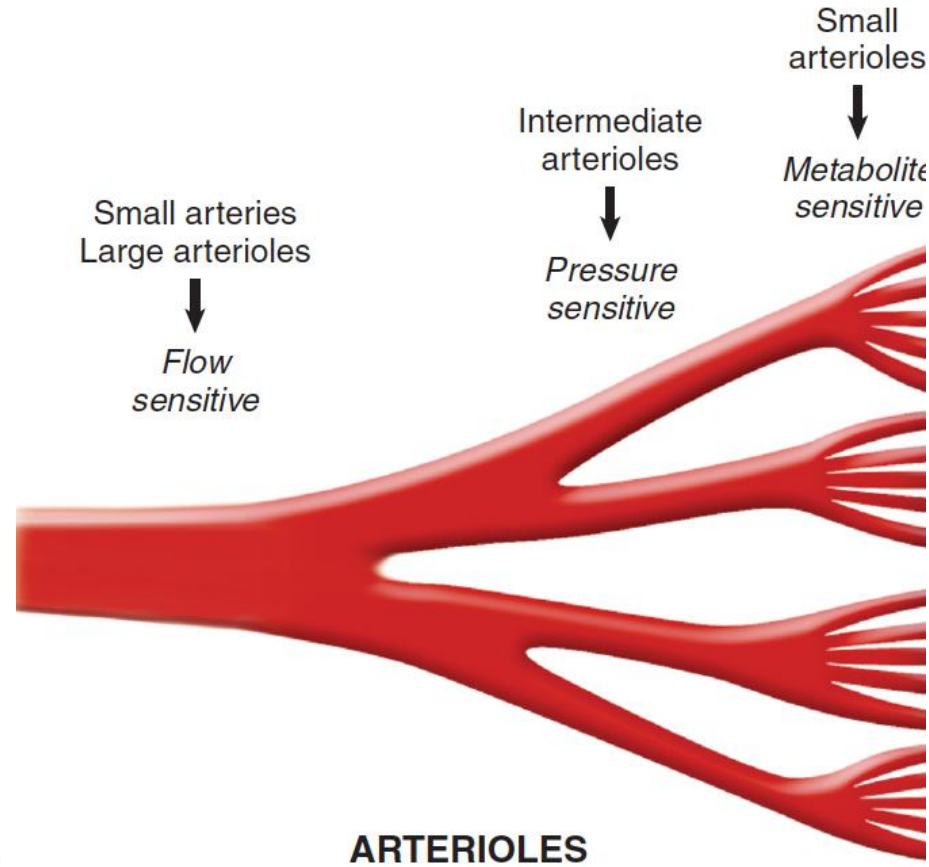
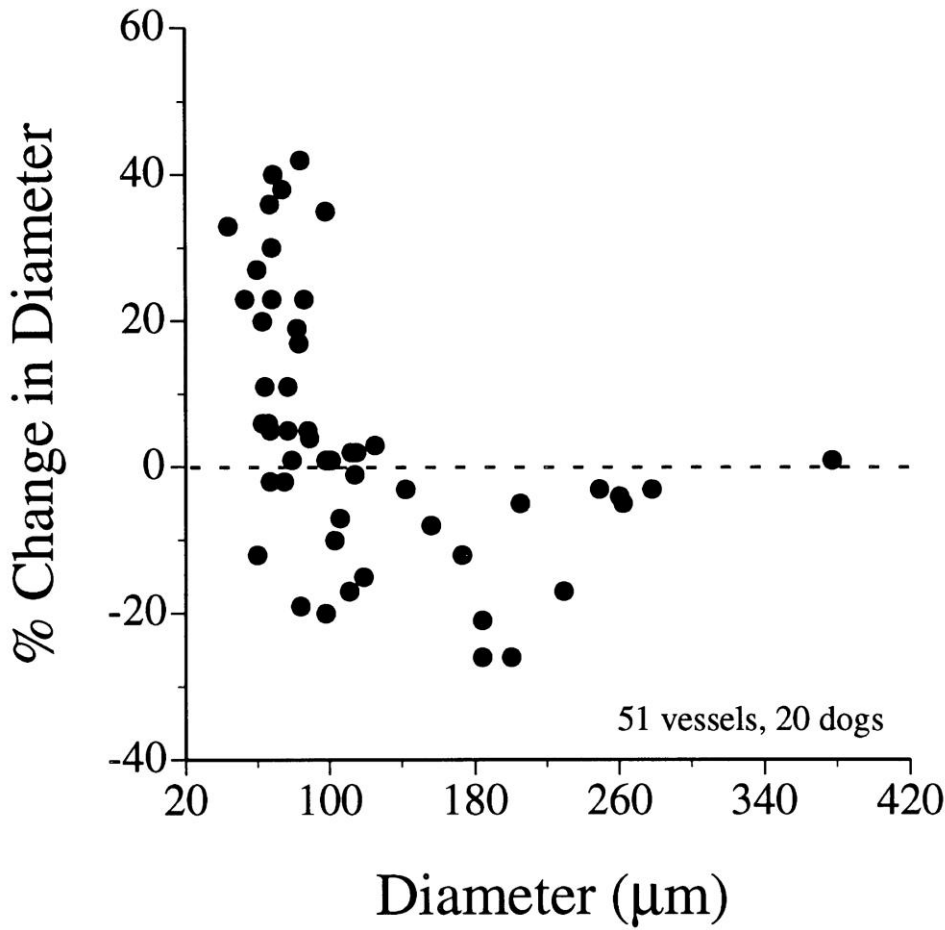
Myocardial blood flow during exercise

Effect of endothelial NO synthase inhibition



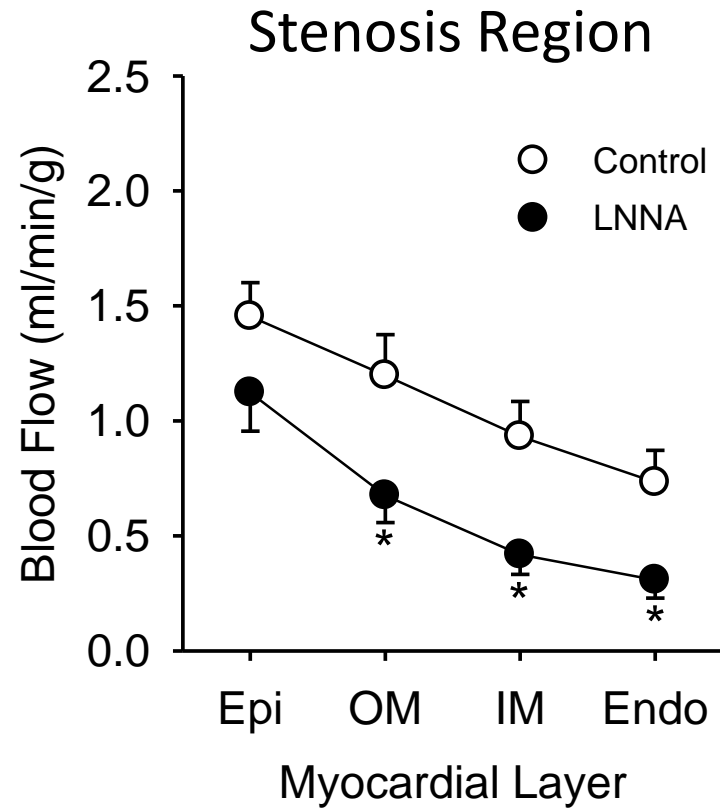
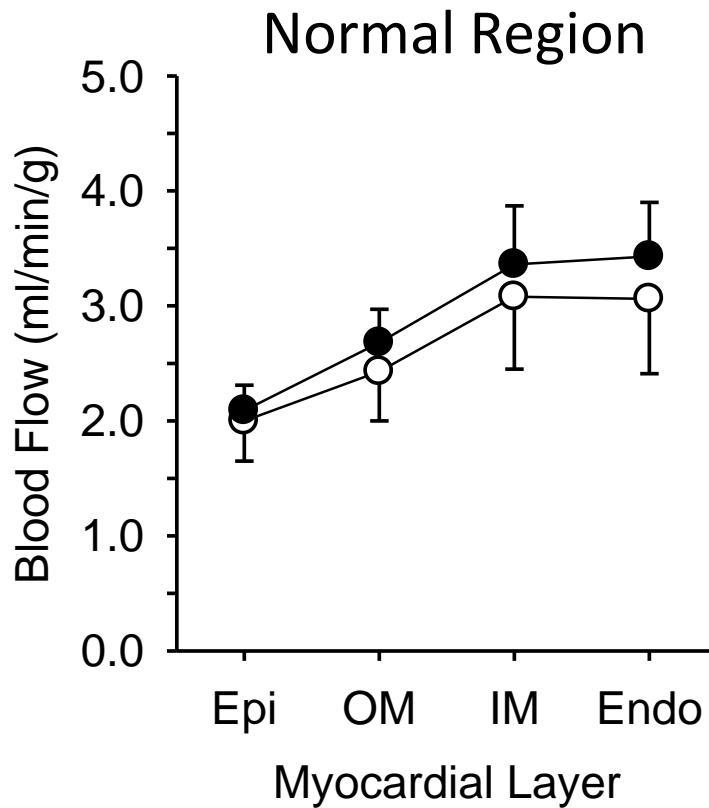
Coronary Microvascular Diameter

Effect of nitric oxide synthase inhibition



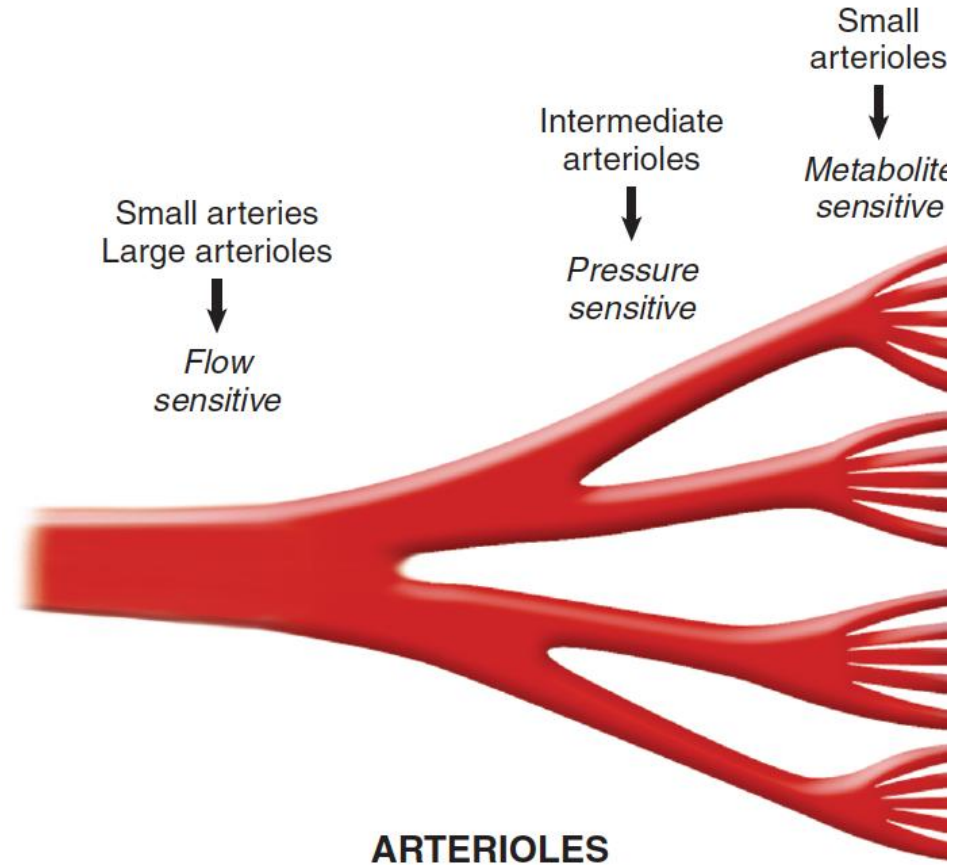
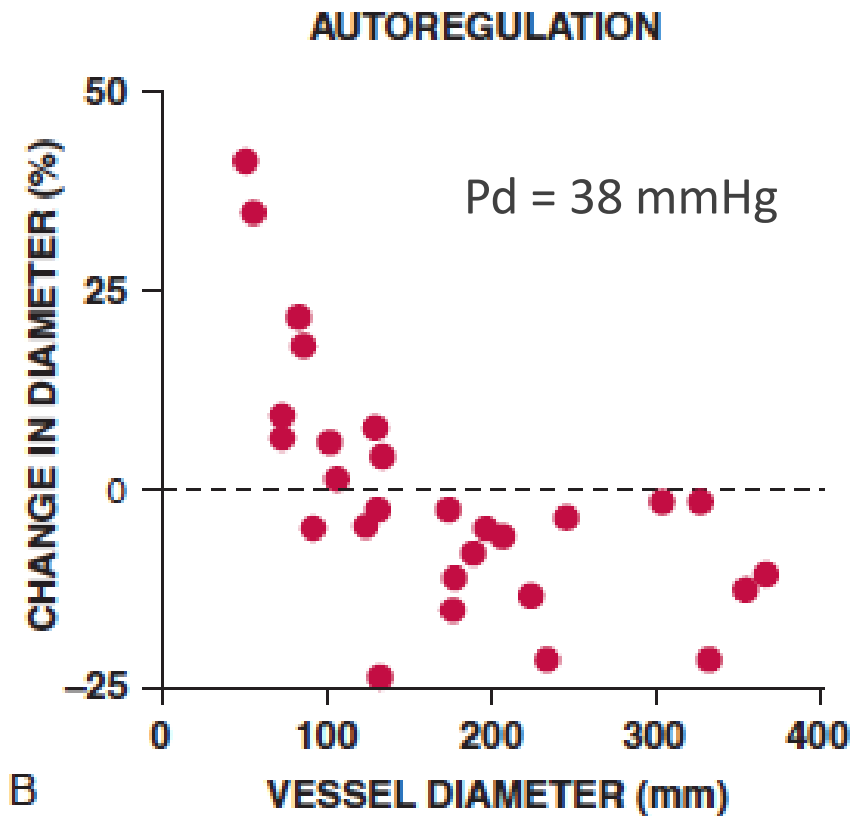
Myocardial blood flow during exercise

Effect of endothelial NO synthase inhibition



Coronary Microvascular Diameter

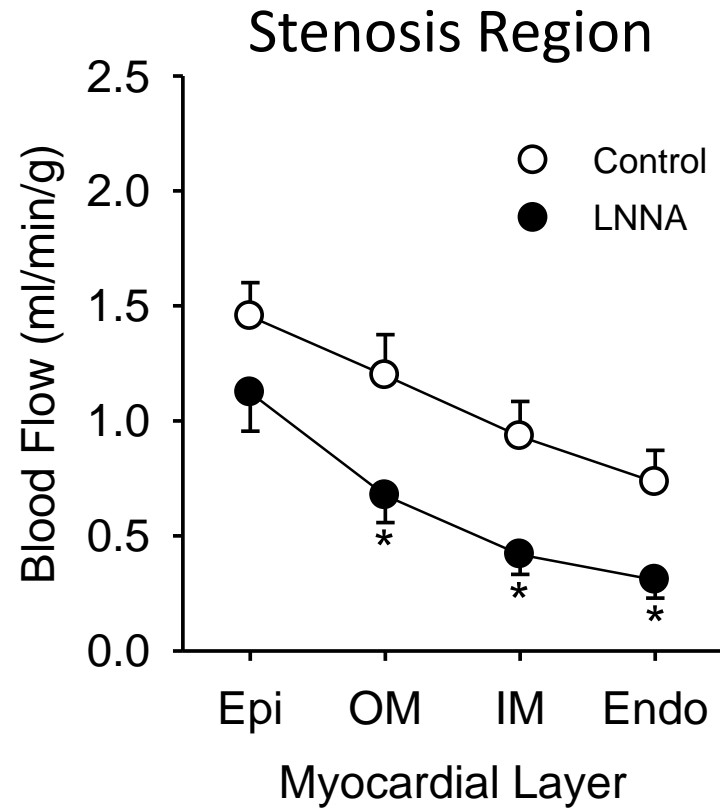
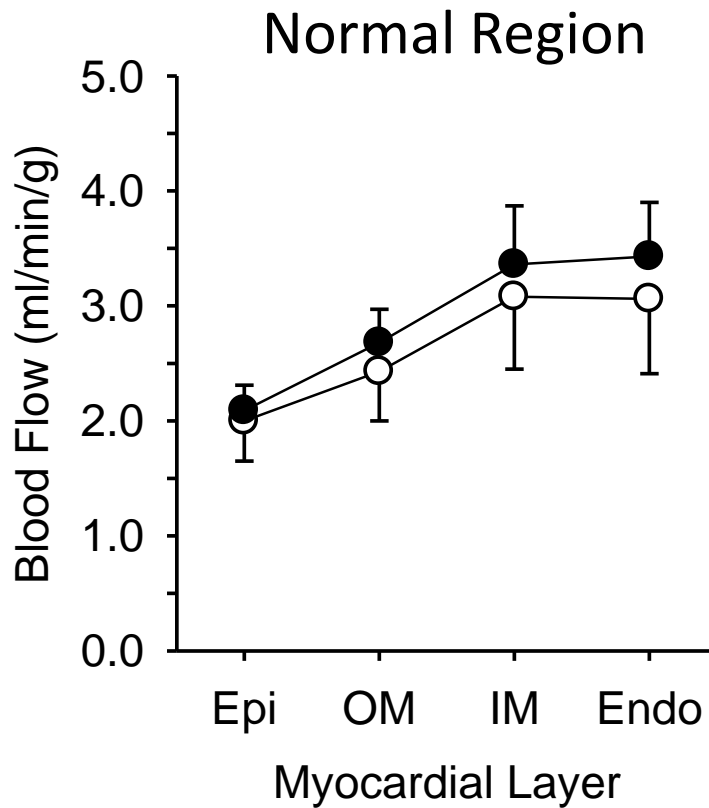
Effect of a coronary artery stenosis



Davis et al APS Handbook of Physiology 2008

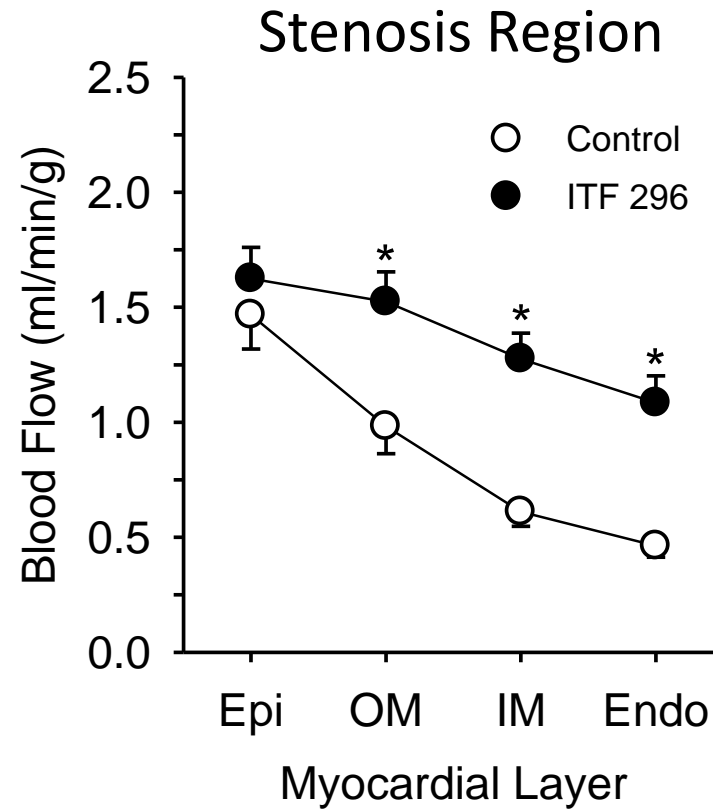
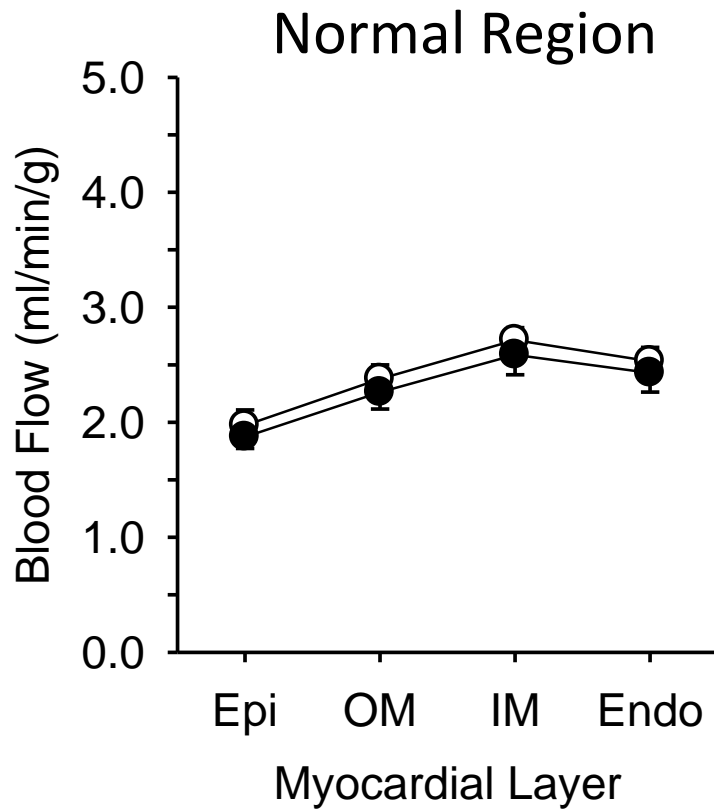
Myocardial blood flow during exercise

Effect of endothelial NO synthase inhibition



Myocardial blood flow during exercise

Effect of a NO donor



Coronary Microvasculature

- Microvascular resistance
 - Longitudinal aspects
 - Transmural aspects
- *Effects of a coronary artery stenosis*
 - Acute
 - ***Chronic***

Duncker & Bache *Pharm Ther* 2000

Duncker & Bache *Physiol Rev* 2008

Laughlin et al *Compr Physiol* 2012

Canty & Duncker *Braunwald's Heart Disease* 2014

Chronic Stenosis

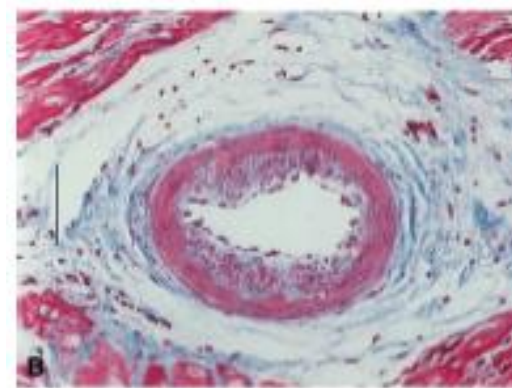
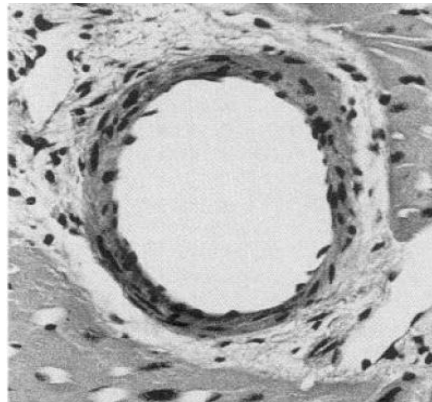
Coronary Microvascular Remodeling

Chronic LAD stenosis in swine

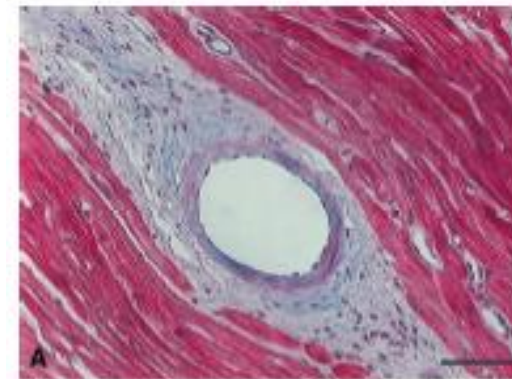
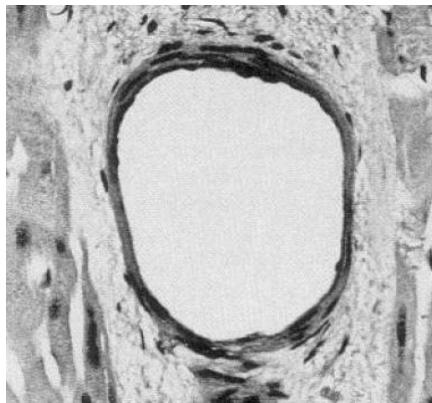
4-32 weeks

4 weeks

LAD
stenosis



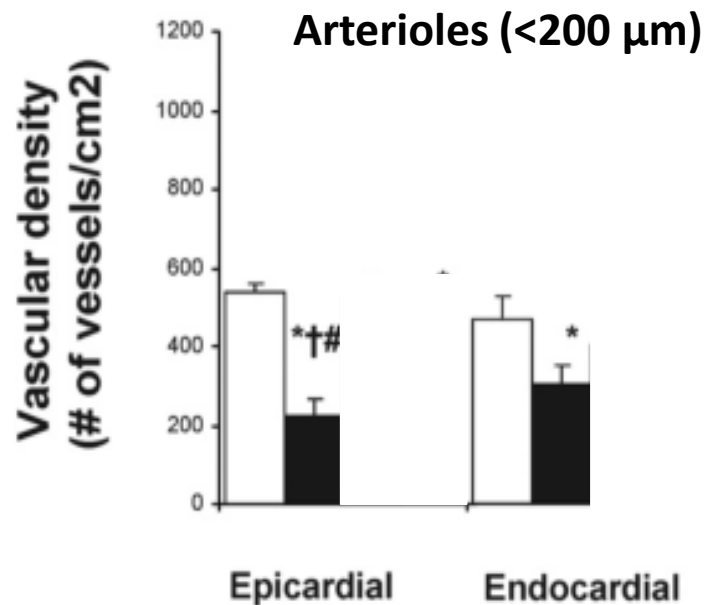
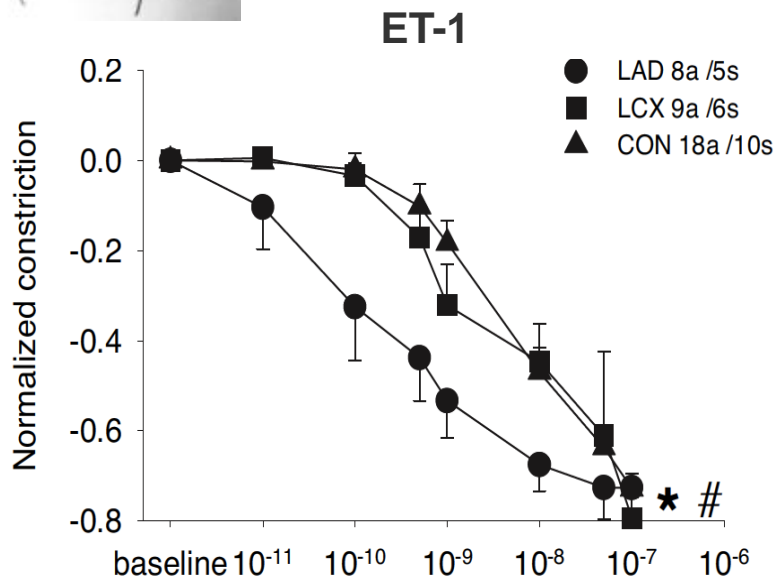
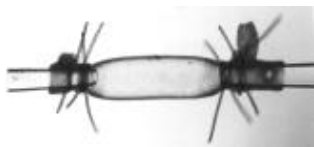
LCX
remote



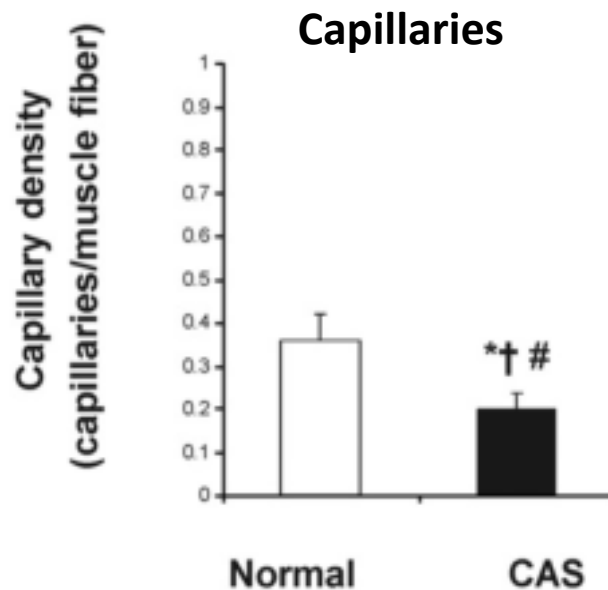
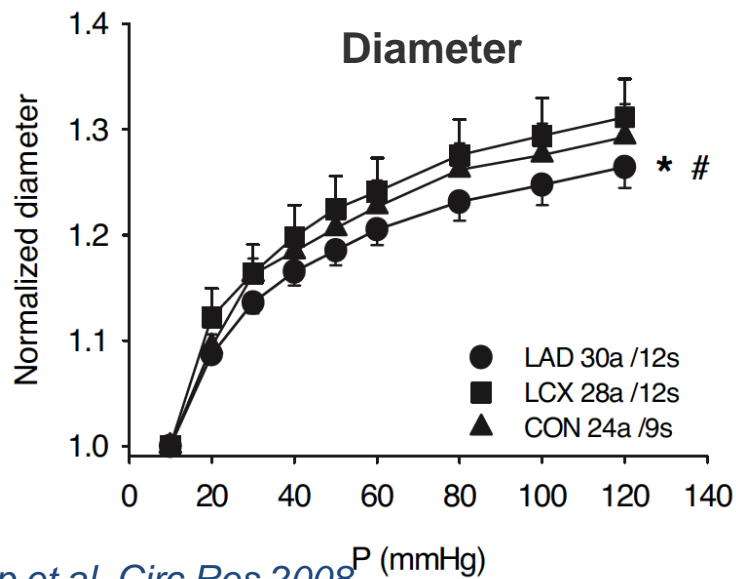
Mills et al AJP 1994

Hong et al ATVB 2002

Coronary Microvascular Abnormalities

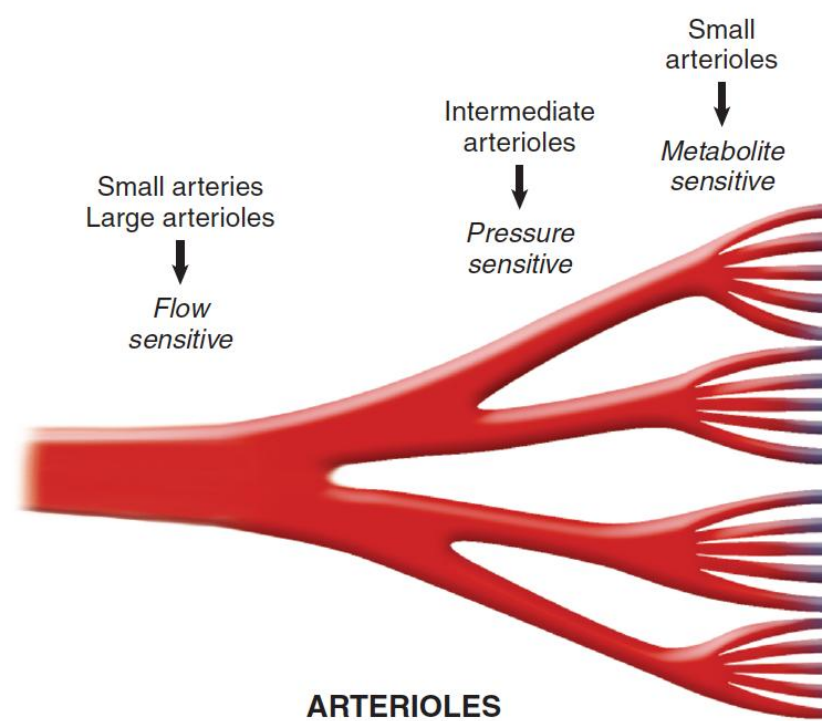
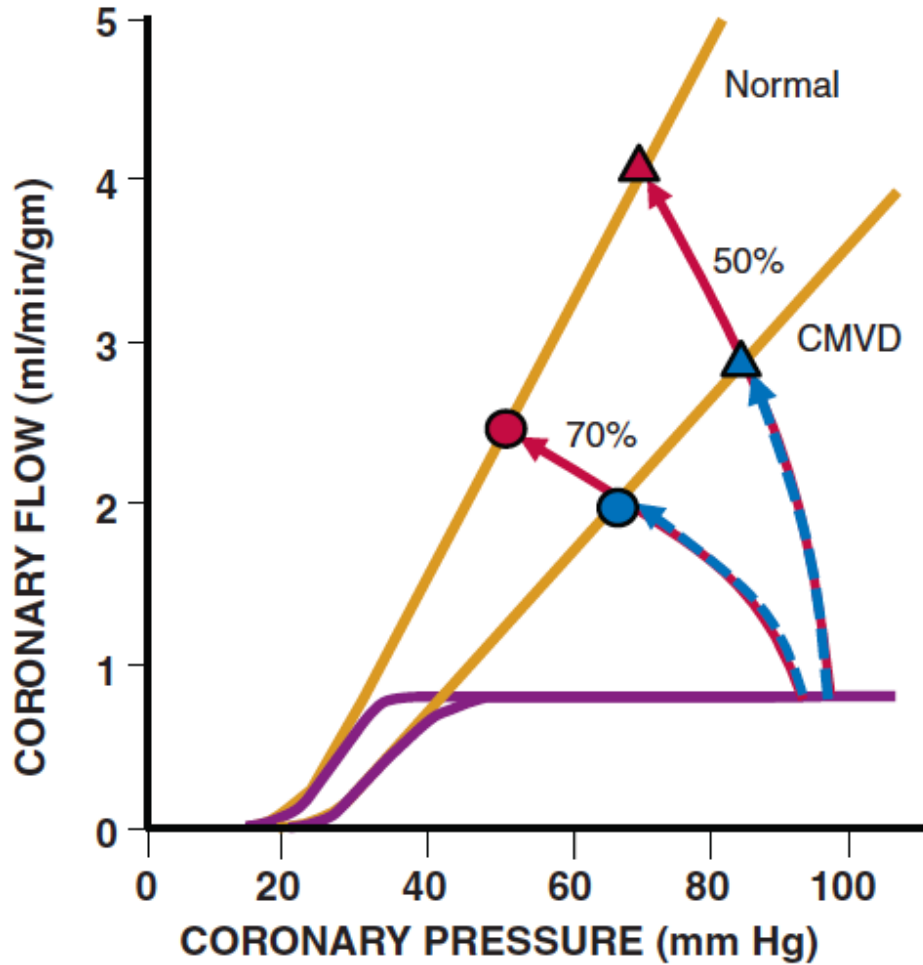


Urbieta et al AJP Heart 2011

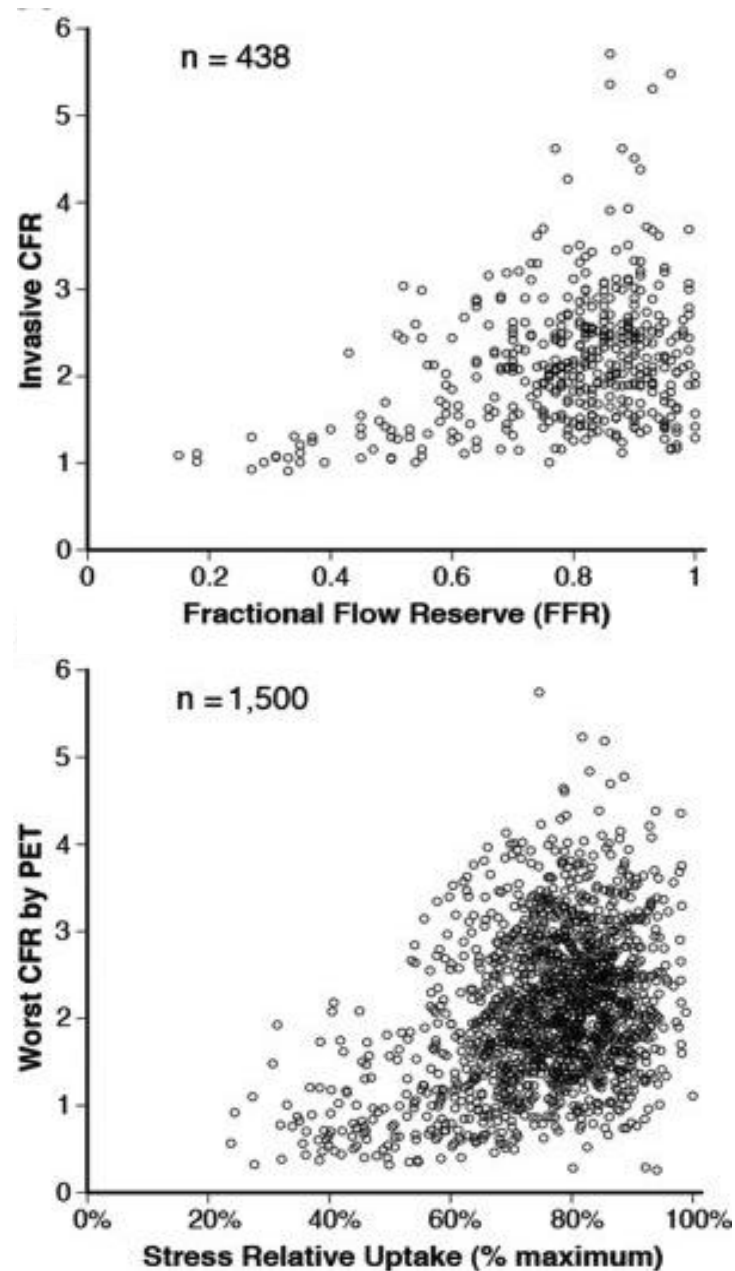
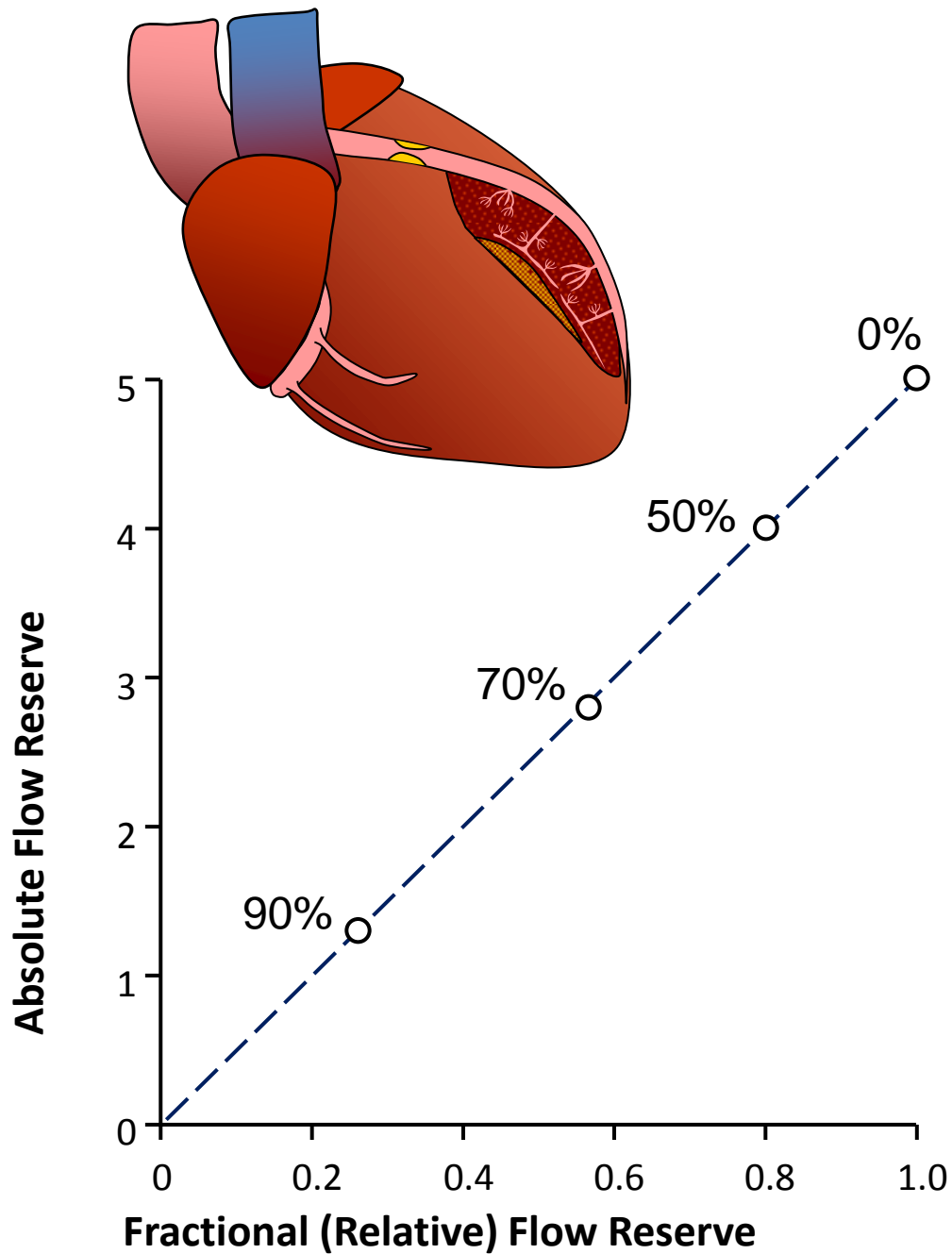


Coronary Pressure-Flow Relation

Influence of Coronary Microvascular Disease



ARTERIOLES



Coronary Microvasculature

- The coronary microvasculature is not a single homogeneous compartment
- A significant part of resistance resides in small arteries that are not under metabolic control
- Residual tone in these small arteries aggravates (subendo-) myocardial ischemia
- Functional and structural alterations in small arteries may contribute to myocardial ischemia in patients with coronary artery disease

Duncker & Bache *Pharm Ther* 2000

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