

Coronary Microvasculature

Structure..... and function

24-04-2015

Dirk J. Duncker

No Disclosures

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

Canty & Duncker *Braunwald's Heart Disease* 2014

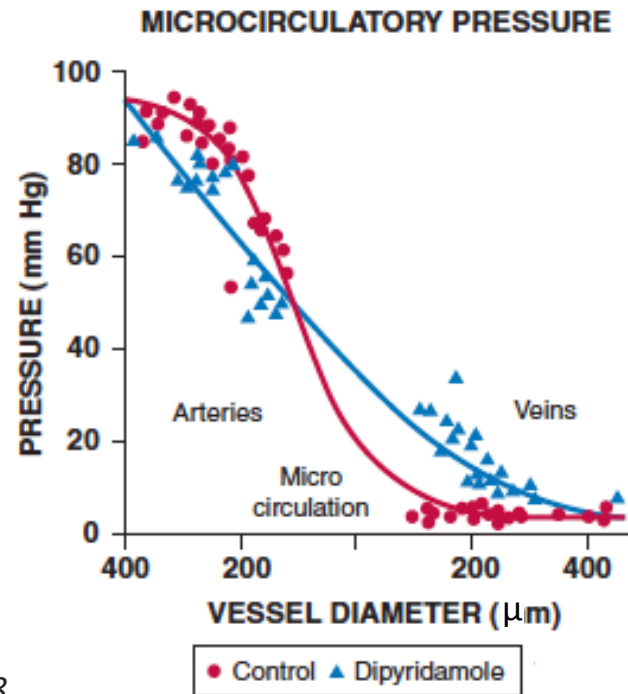
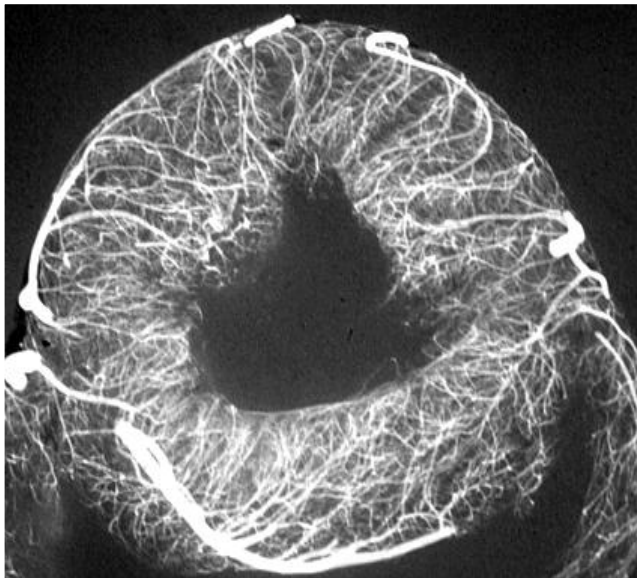
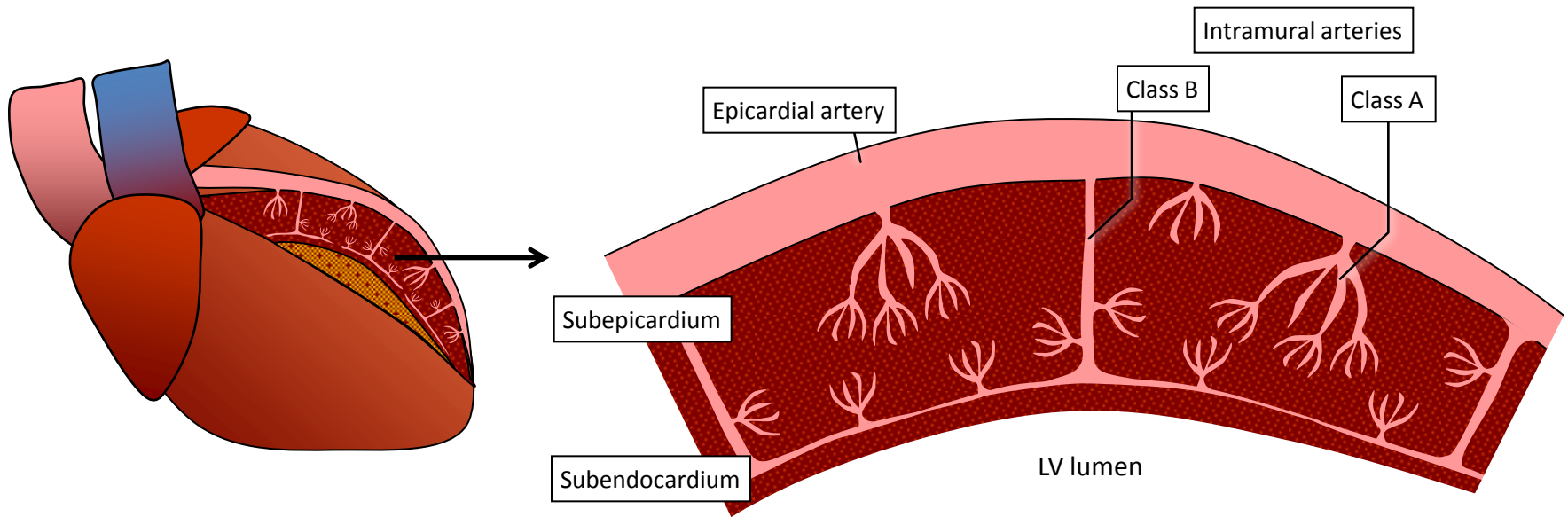
Coronary Microvasculature

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

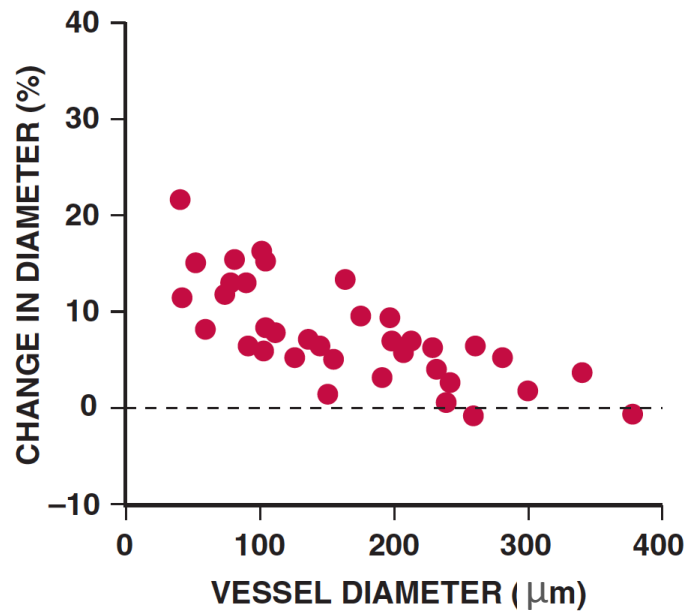
Duncker & Bache *Pharm Ther* 2000

Duncker & Bache *Physiol Rev* 2008

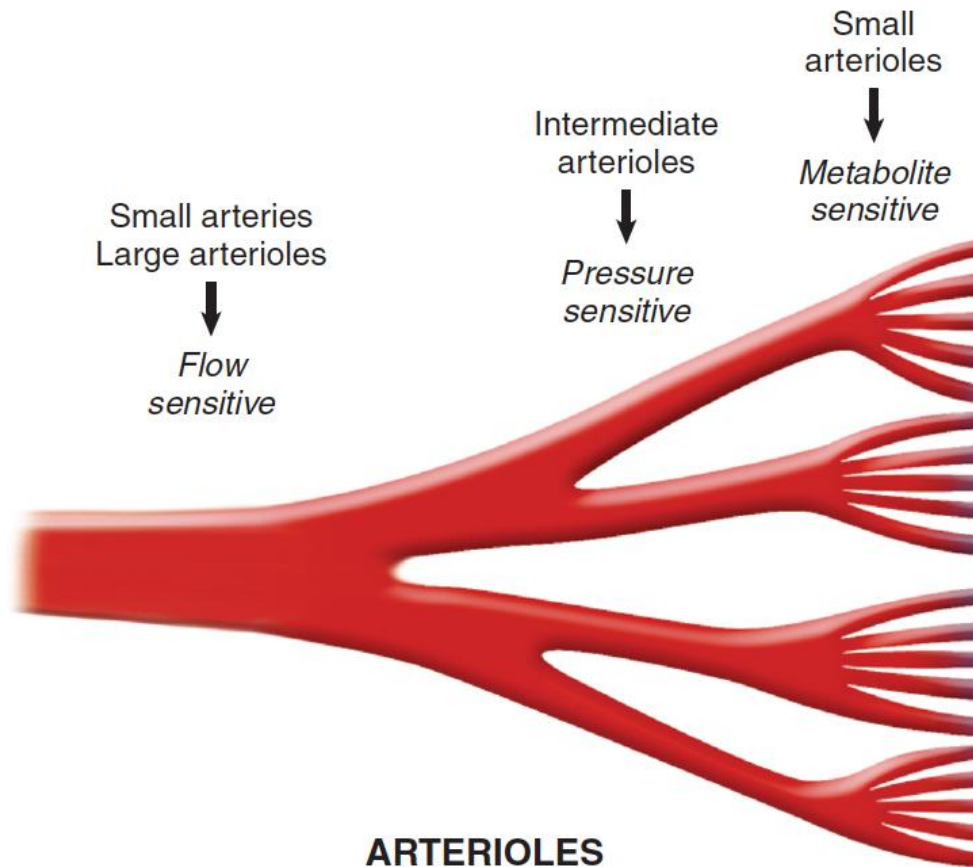
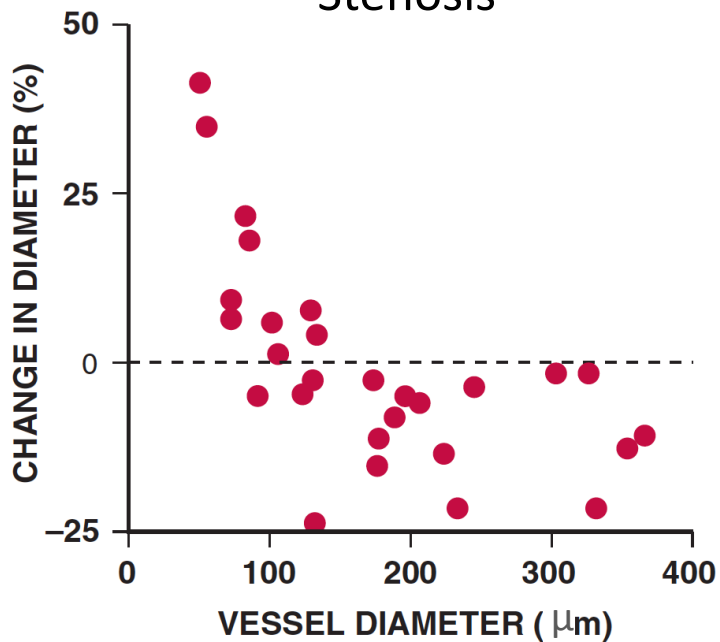
Canty & Duncker *Braunwald's Heart Disease* 2014



METABOLIC VASODILATION



Stenosis



ARTERIOLES

Davis et al APS Handbook of Physiology 2008

Coronary Microvasculature

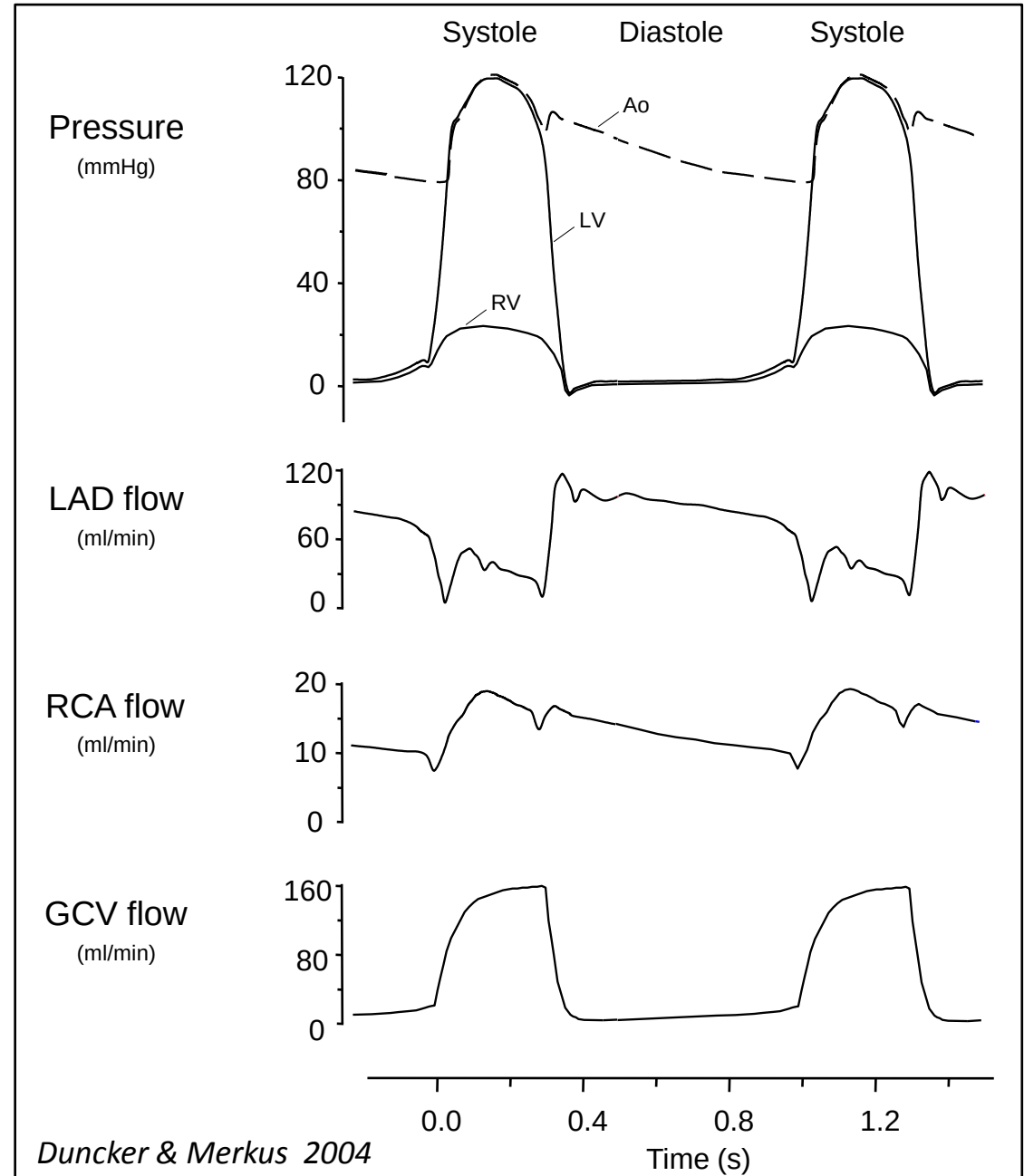
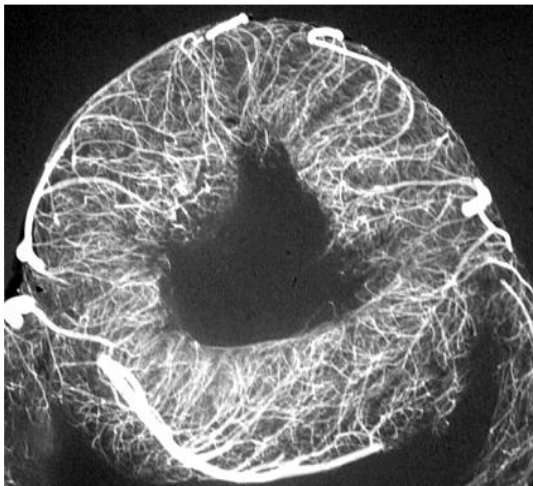
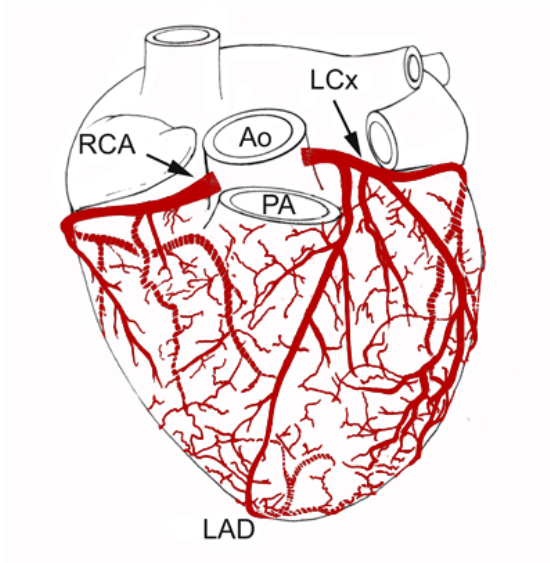
- *Microvascular resistance*
 - Longitudinal aspects
 - ***Transmural aspects***
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Duncker & Bache *Pharm Ther* 2000

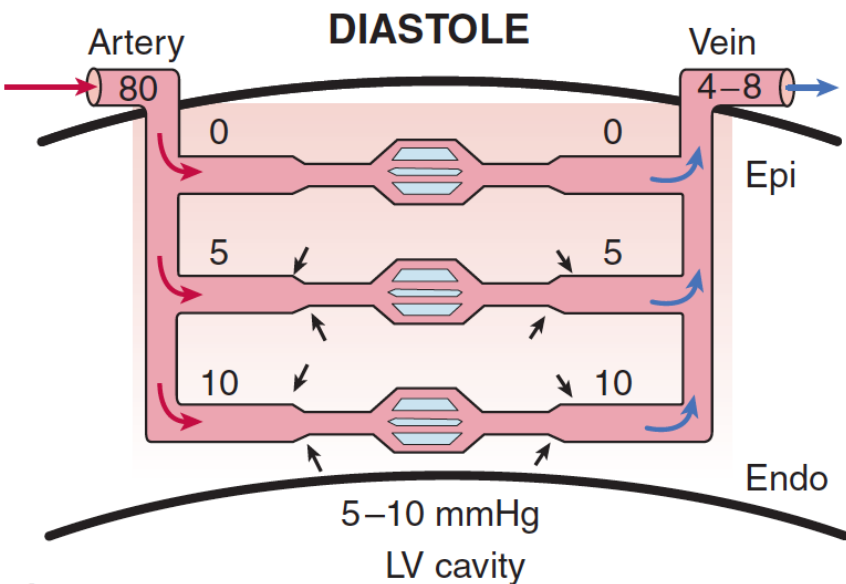
Duncker & Bache *Physiol Rev* 2008

Canty & Duncker *Braunwald's Heart Disease* 2014

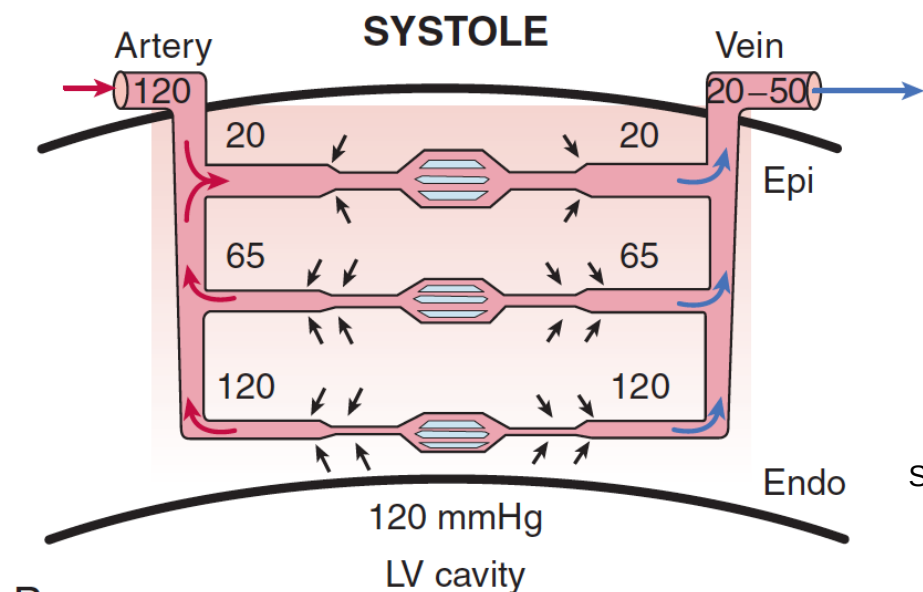
Cyclic Compression of the Coronary Microvasculature



Intramyocardial Pump



A



B

ETP April 24-26, 2014

Pressure
(mmHg)

LAD flow
(ml/min)

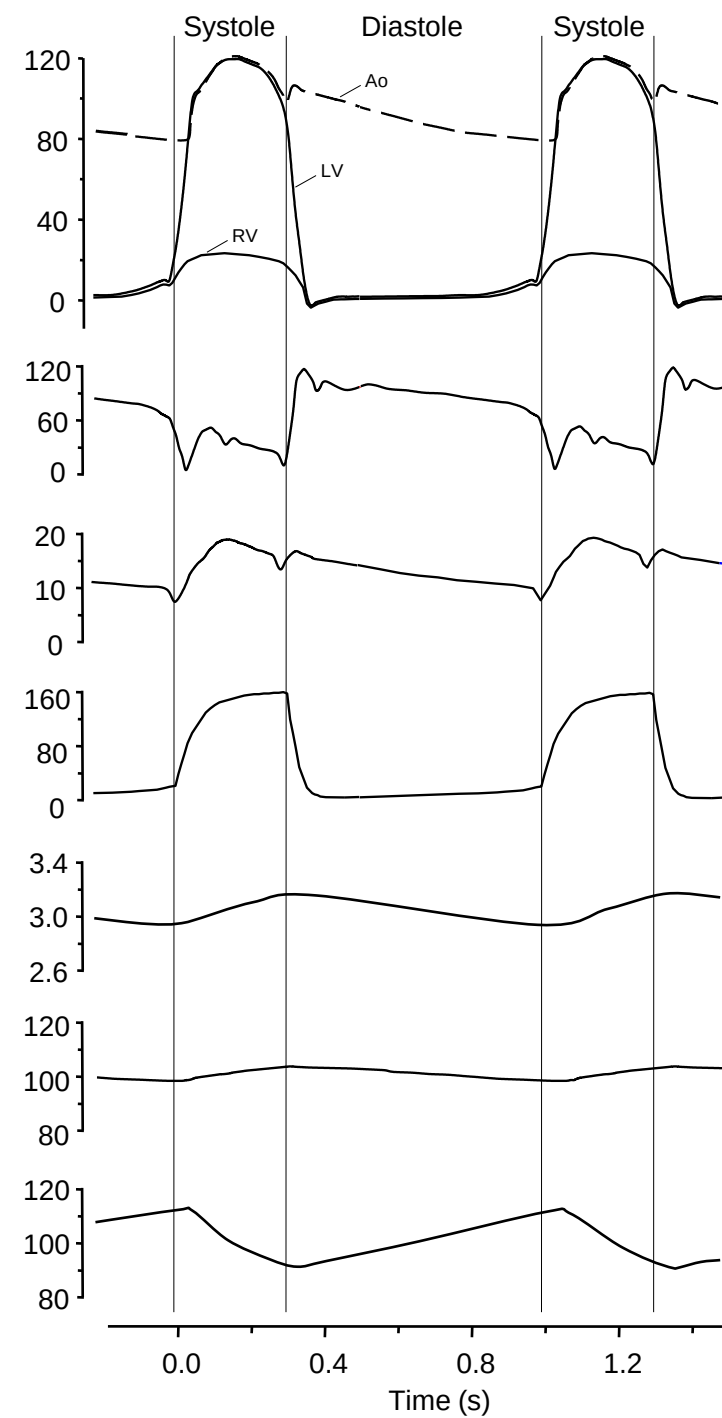
RCA flow
(ml/min)

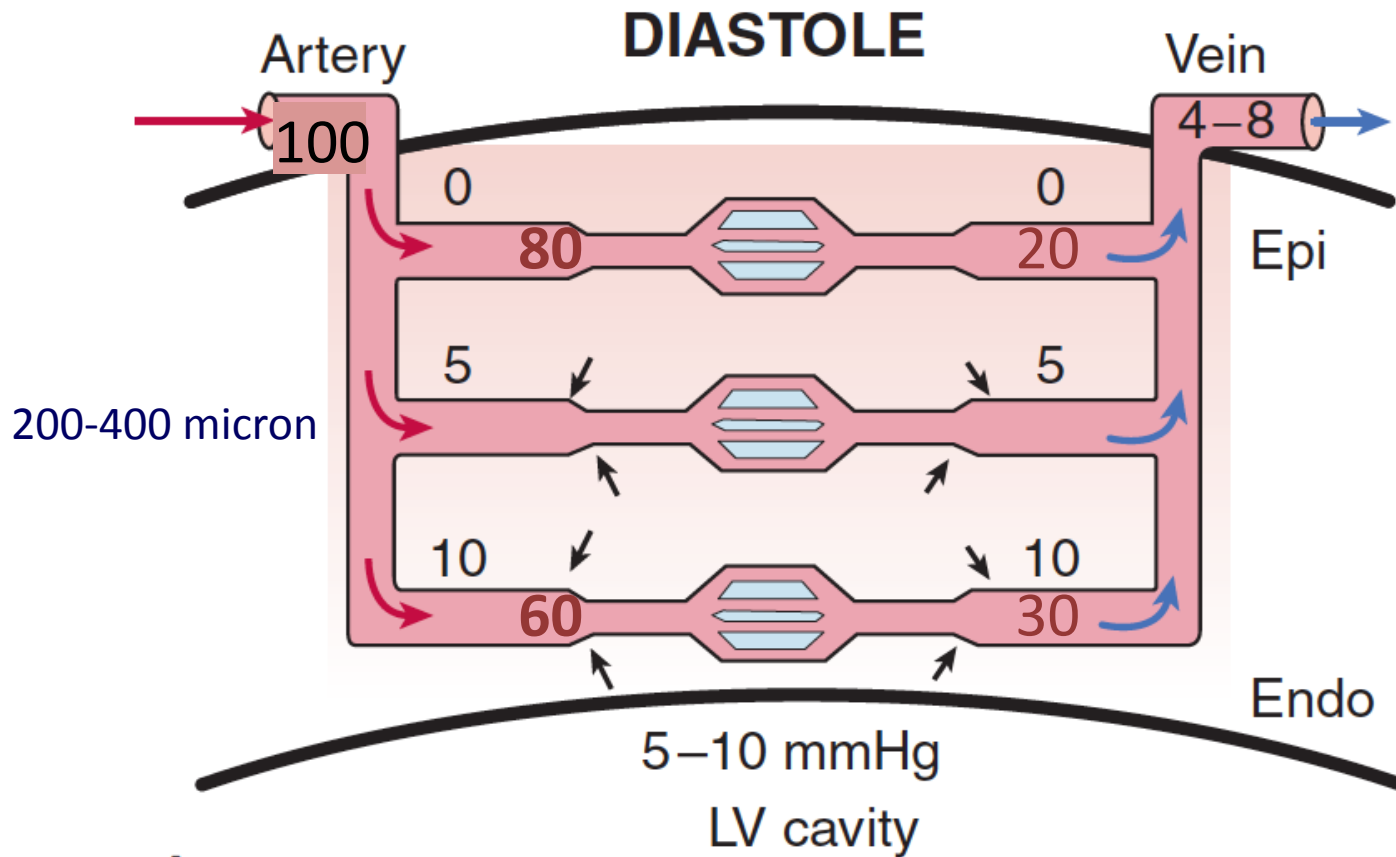
GCV flow
(ml/min)

Diameter
LAD
(mm)

Diameter
Subepicardial
Arteriole
(μ m)

Diameter
Subendocardial
Arteriole
(μ m)

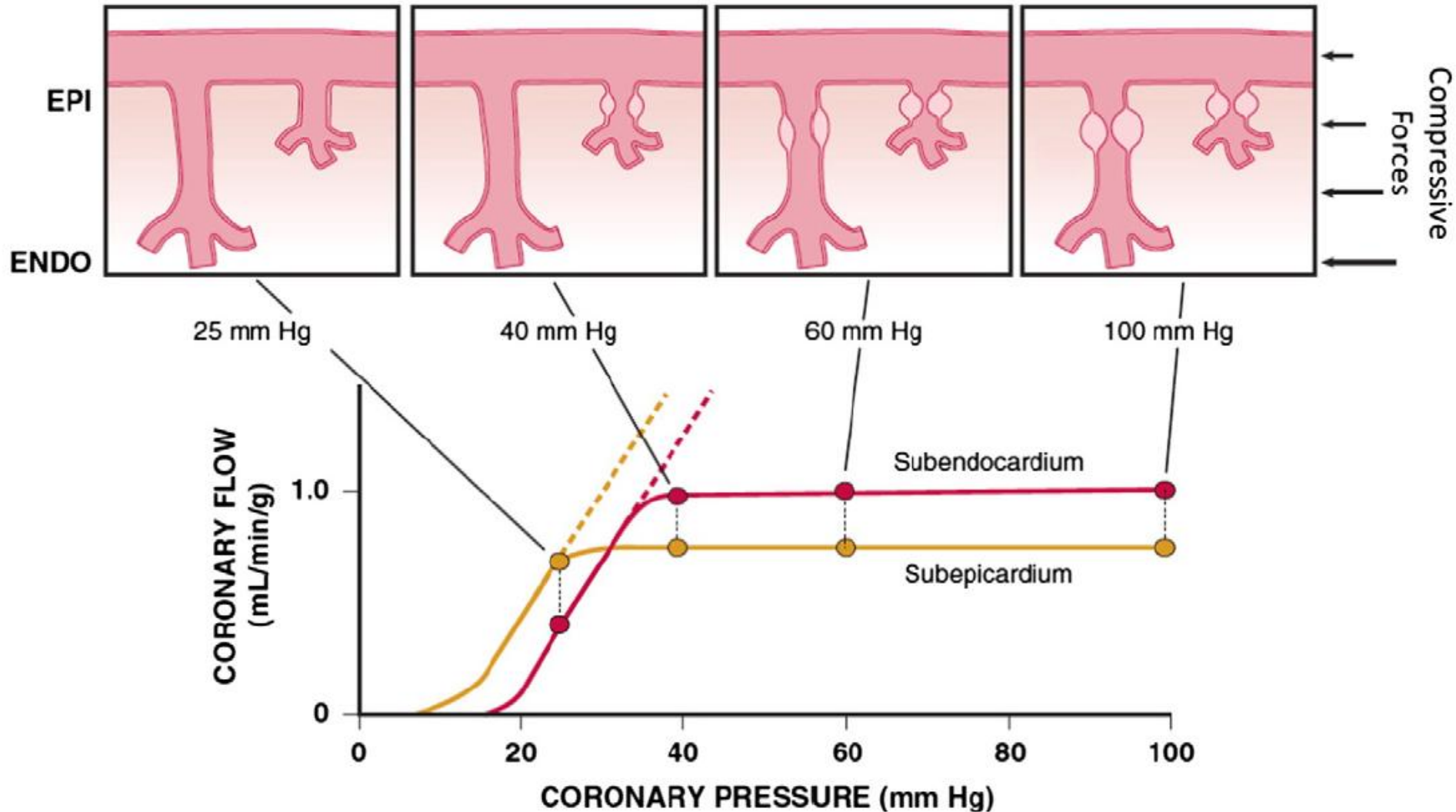




1. Compression greater in subendocardium
 2. Arteriolar pressure lower in subendocardium
- *~10% higher subendocardial vascular density*

Coronary Pressure-Flow Relation

Subendocardial Vulnerability



Coronary Microvasculature

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 - **Acute**
 - chronic

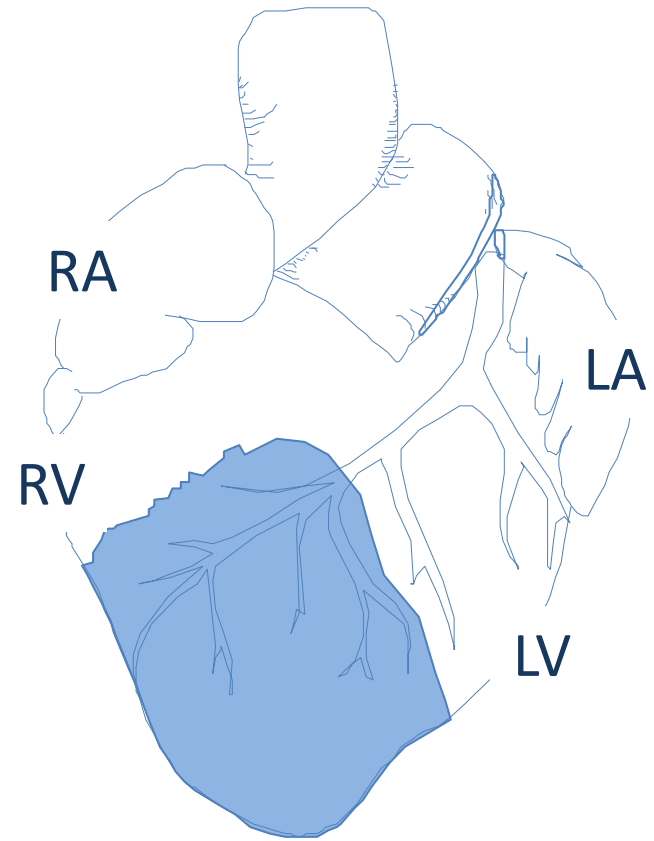
Duncker & Bache *Pharm Ther* 2000

Duncker & Bache *Physiol Rev* 2008

Canty & Duncker *Braunwald's Heart Disease* 2014

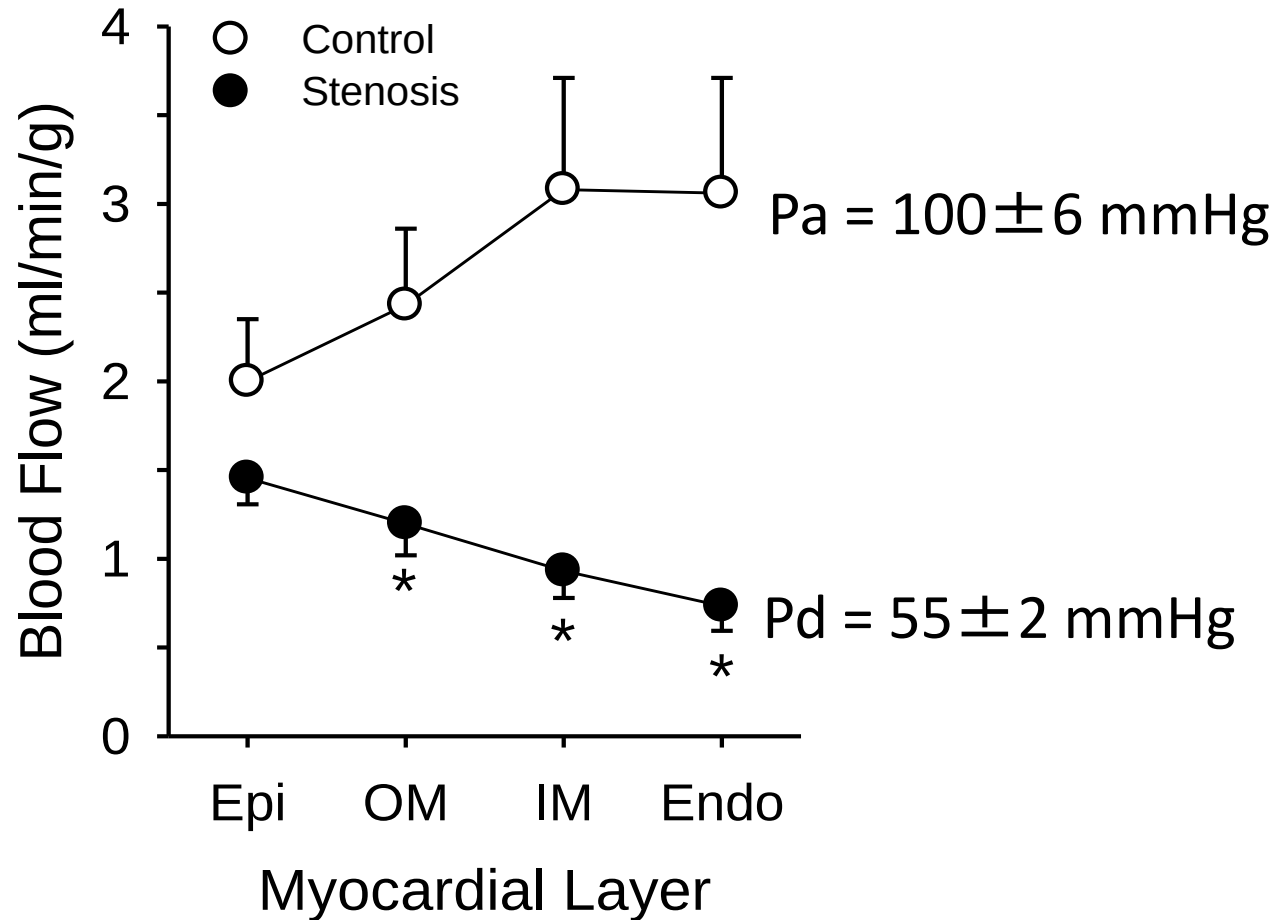
Acute Stenosis Model

- 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



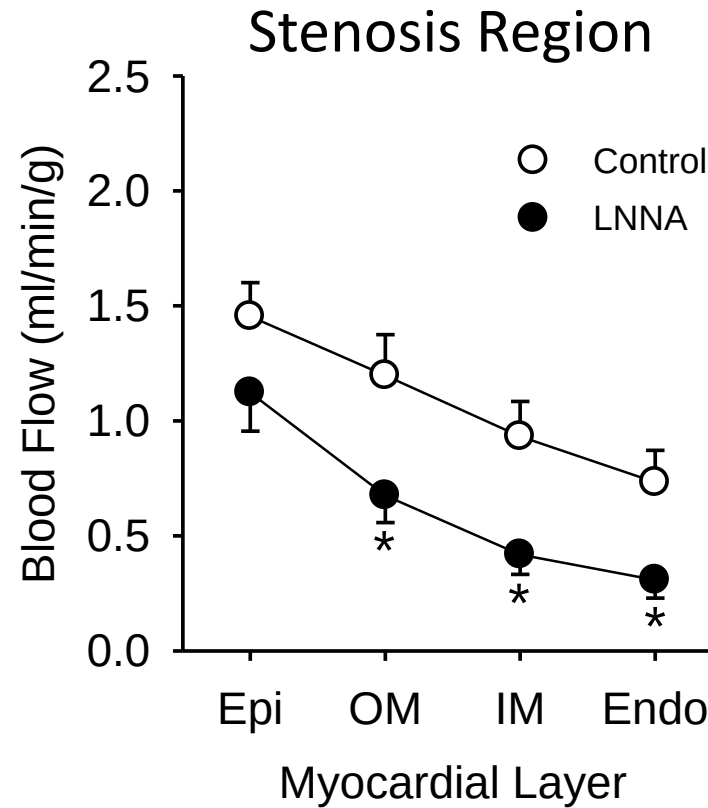
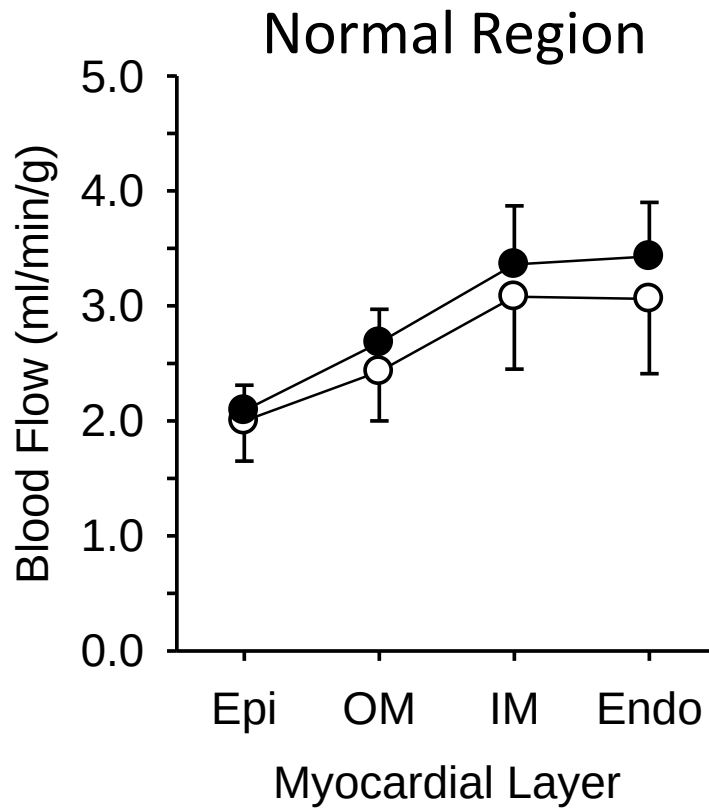
Myocardial blood flow during exercise

Effect of reduced coronary artery pressure



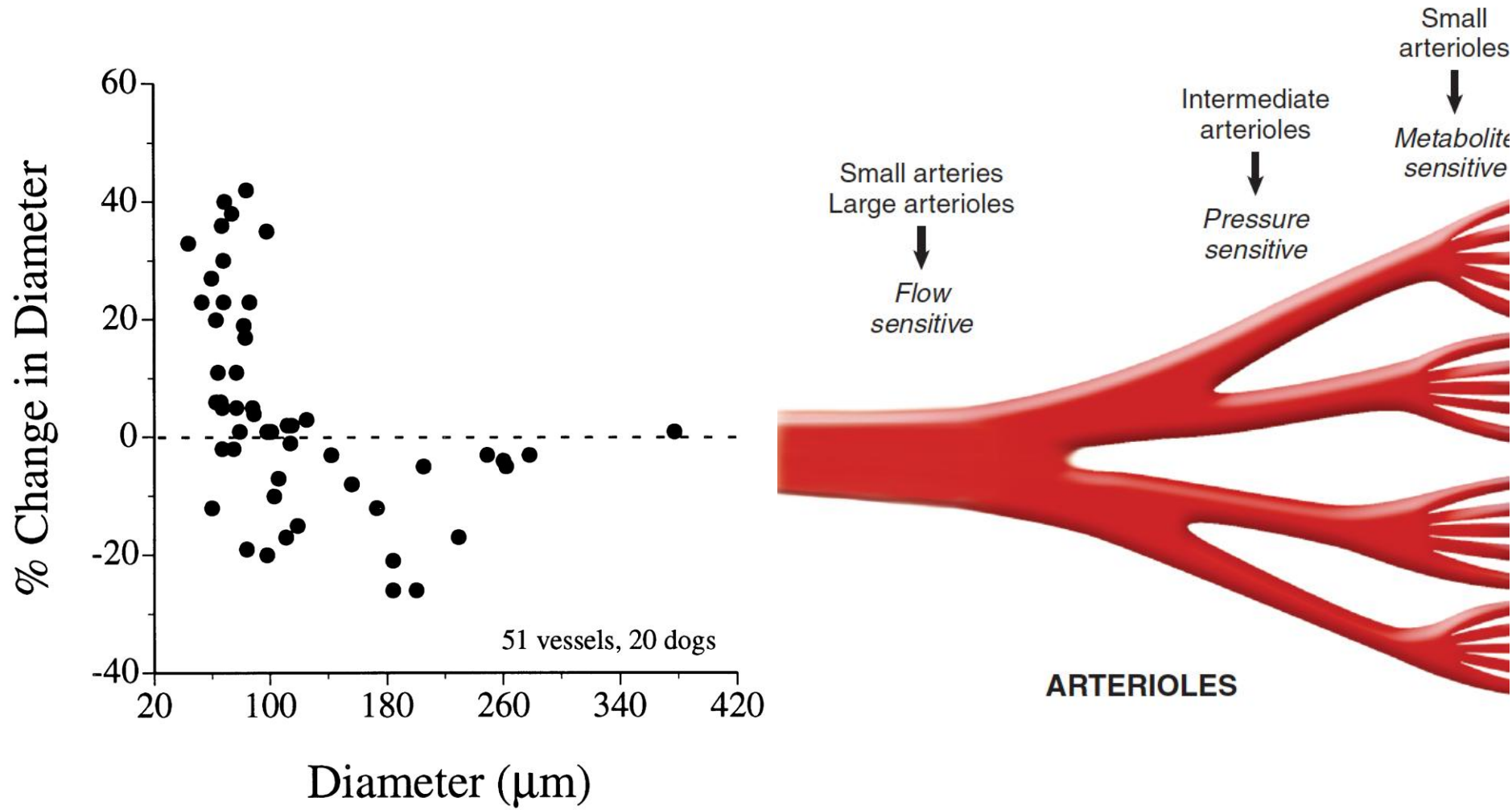
Myocardial blood flow during exercise

Effect of endothelial NO synthase inhibition



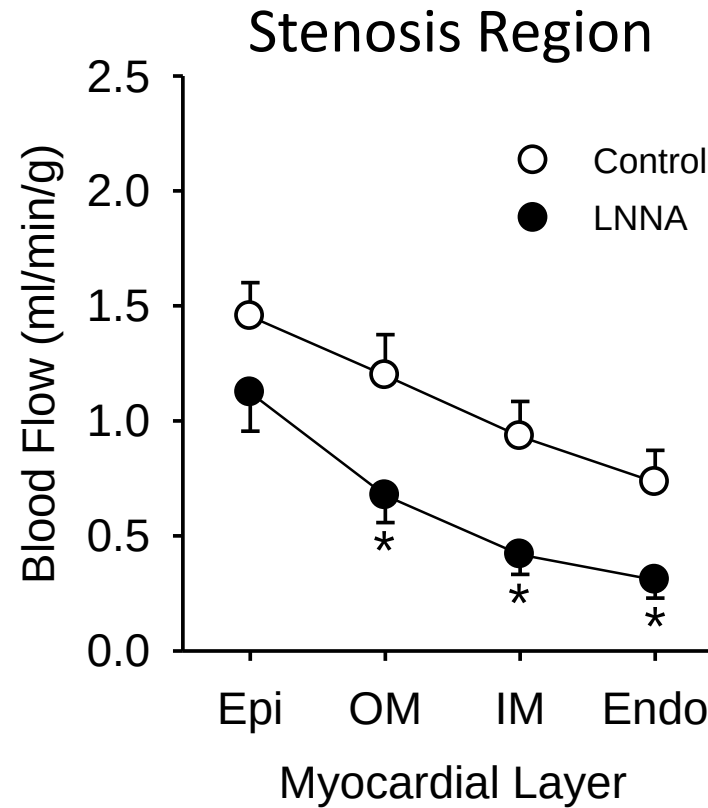
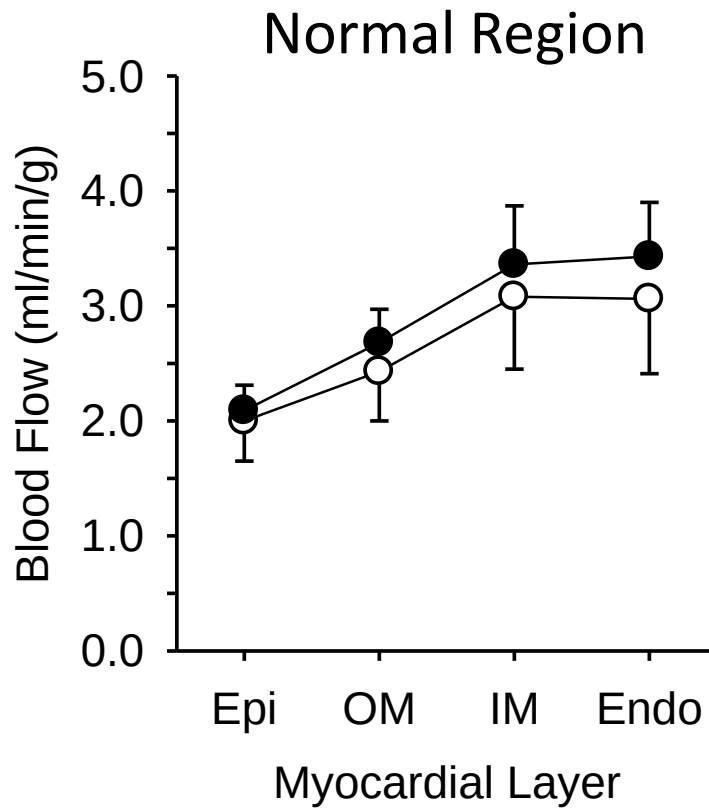
Coronary Microvascular Diameter

Effect of nitric oxide synthase inhibition



Myocardial blood flow during exercise

Effect of endothelial NO synthase inhibition

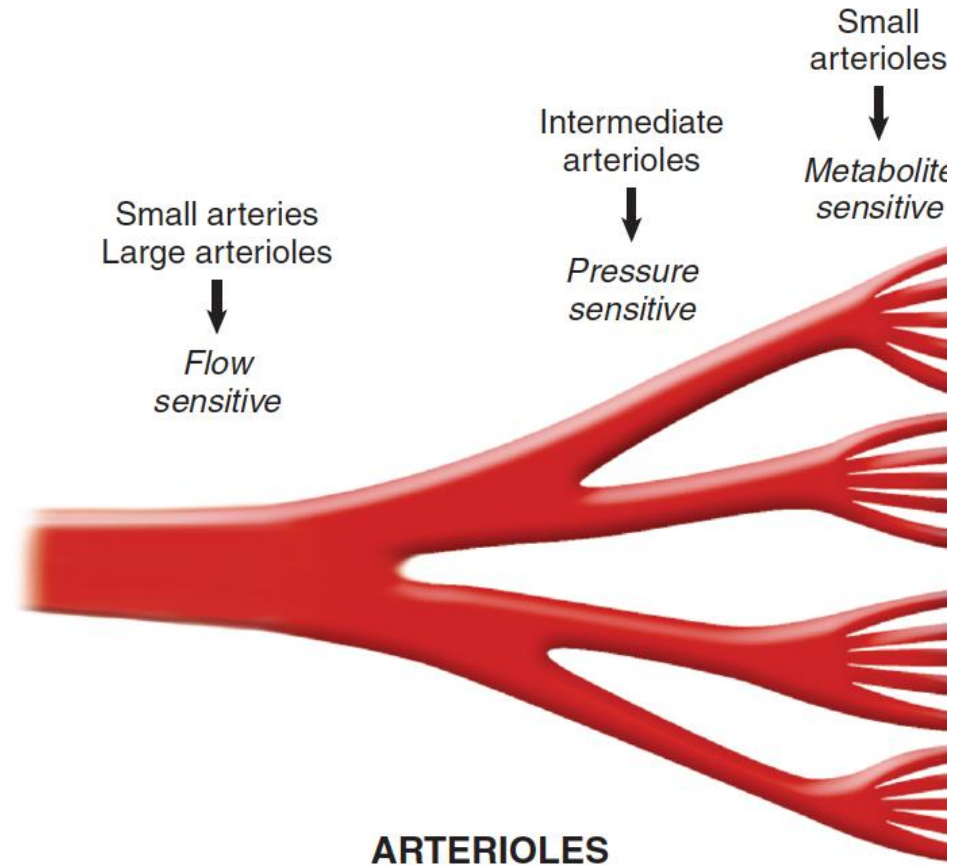
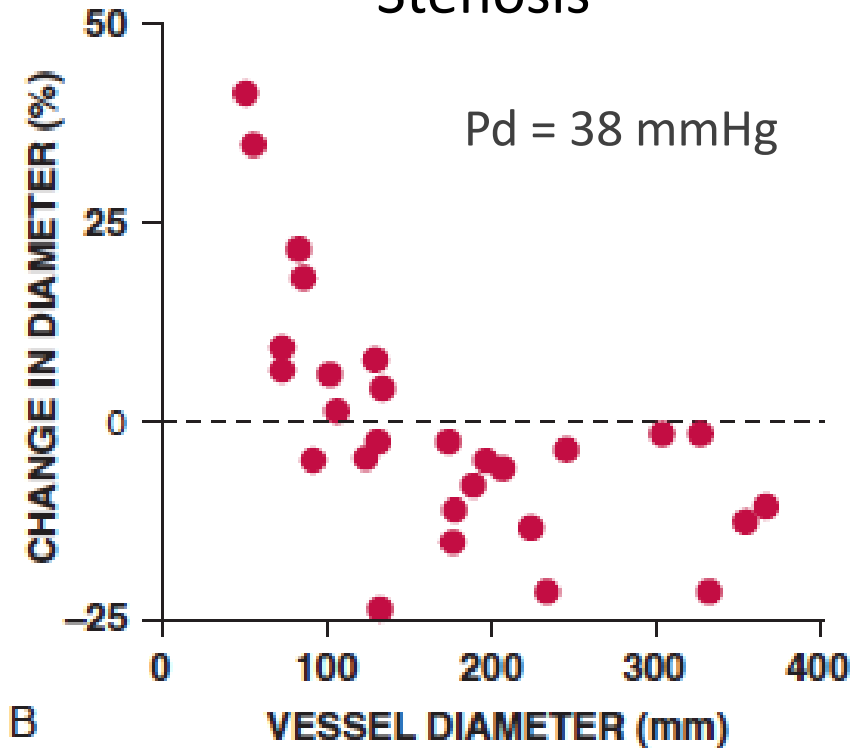


Coronary Microvascular Diameter

Effect of a coronary artery stenosis

Stenosis

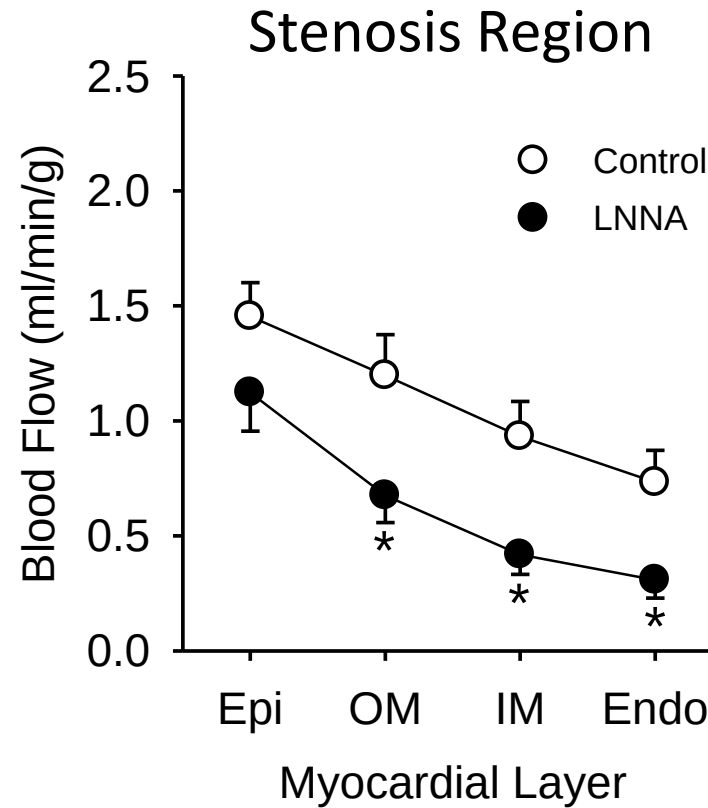
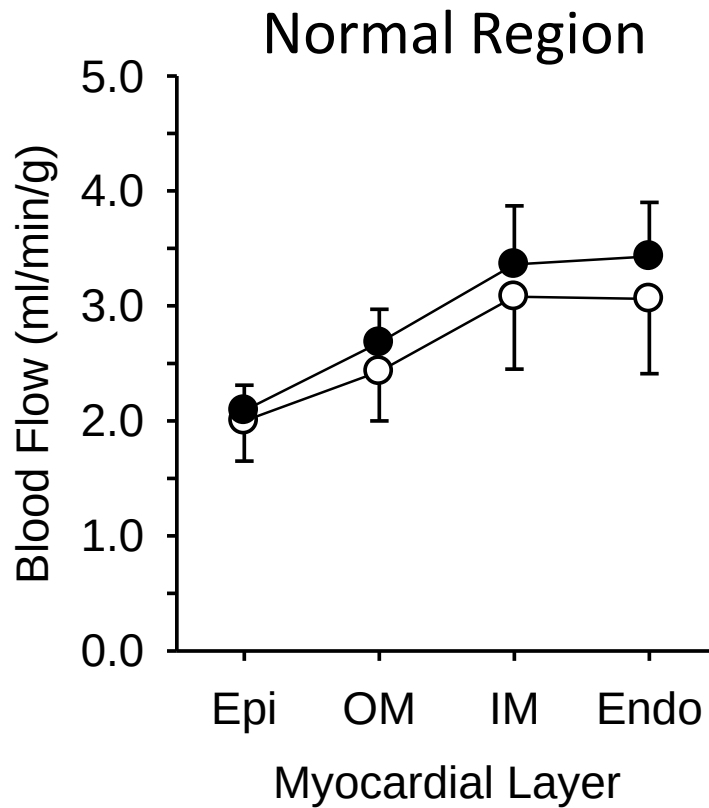
Pd = 38 mmHg



Davis et al APS Handbook of Physiology 2008

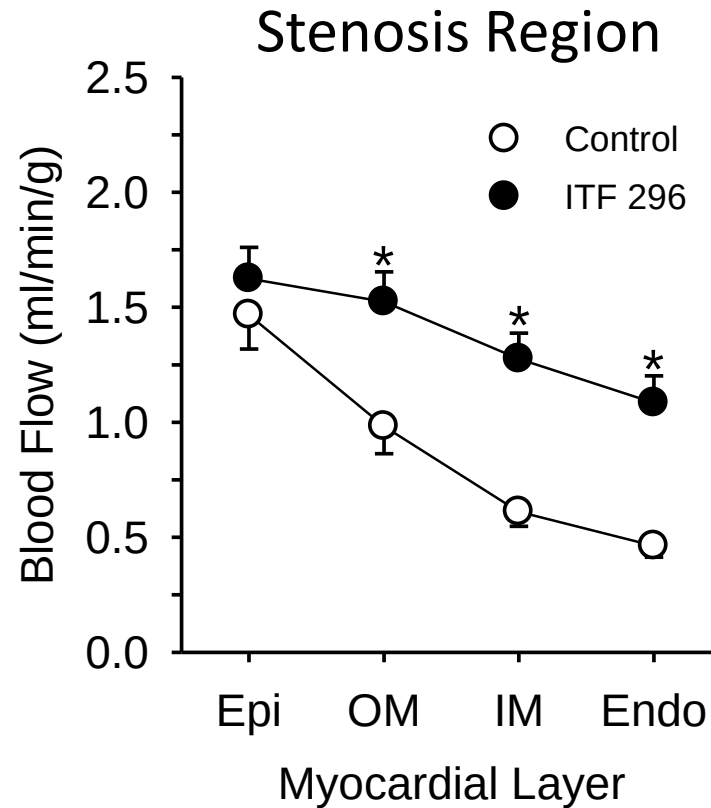
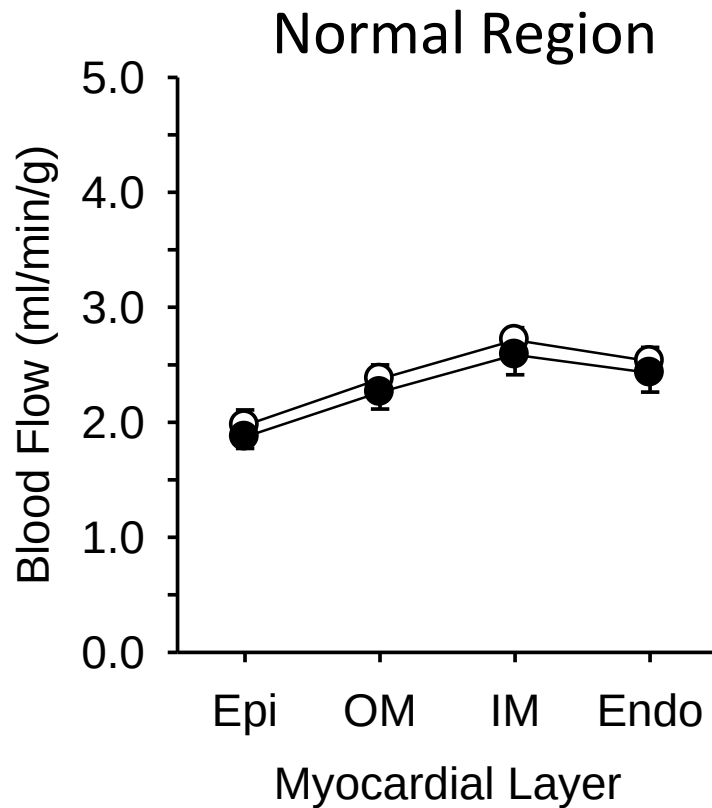
Myocardial blood flow during exercise

Effect of endothelial NO synthase inhibition



Myocardial blood flow during exercise

Effect of a NO donor



Coronary Microvasculature

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

Duncker & Bache *Pharm Ther* 2000

Duncker & Bache *Physiol Rev* 2008

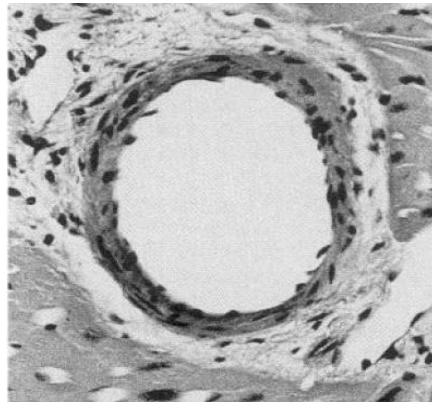
Canty & Duncker *Braunwald's Heart Disease* 2014

Chronic Stenosis

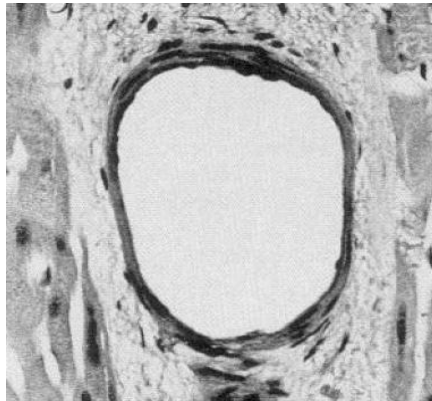
Coronary Microvascular Remodeling

Chronic LAD stenosis in swine
4-32 weeks

LAD
stenosis

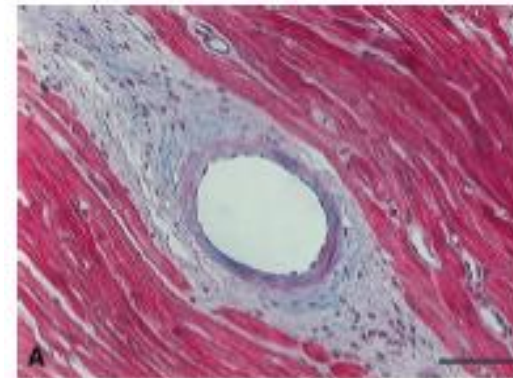
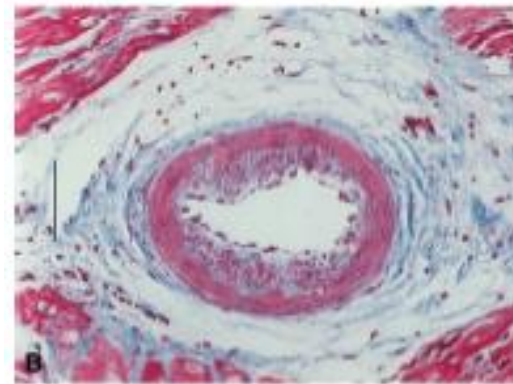


LCX
remote



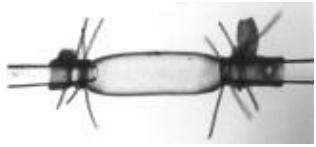
Mills et al AJP 1994

4 weeks

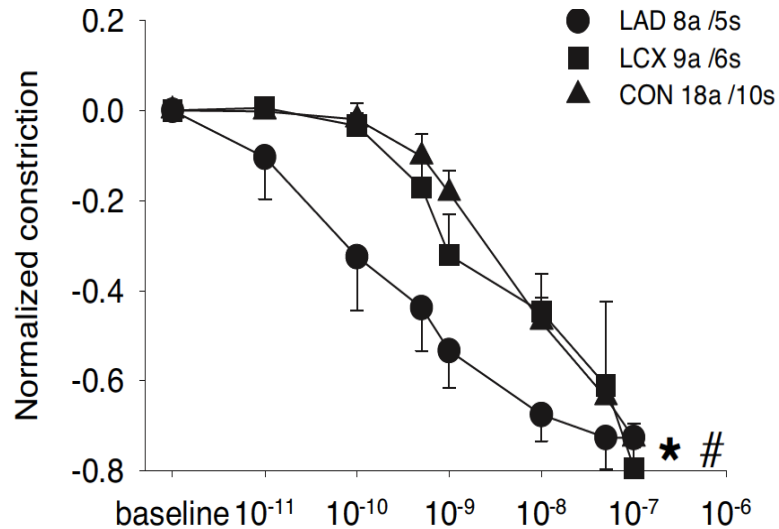


Hong et al ATVB 2002

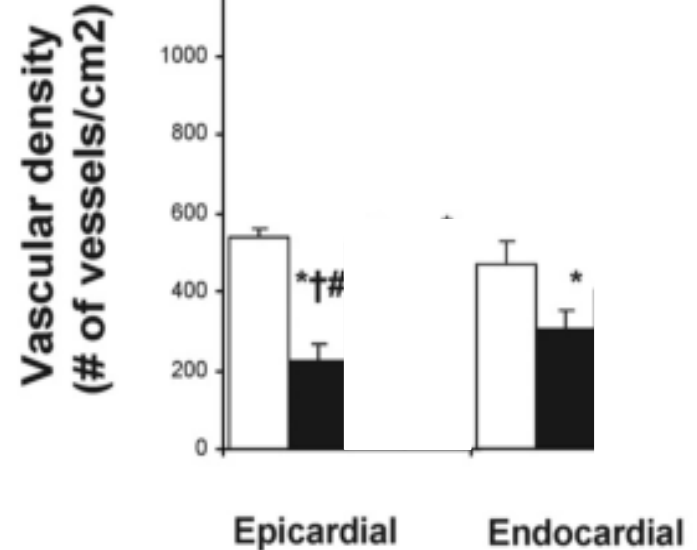
Coronary Microvascular Abnormalities



ET-1

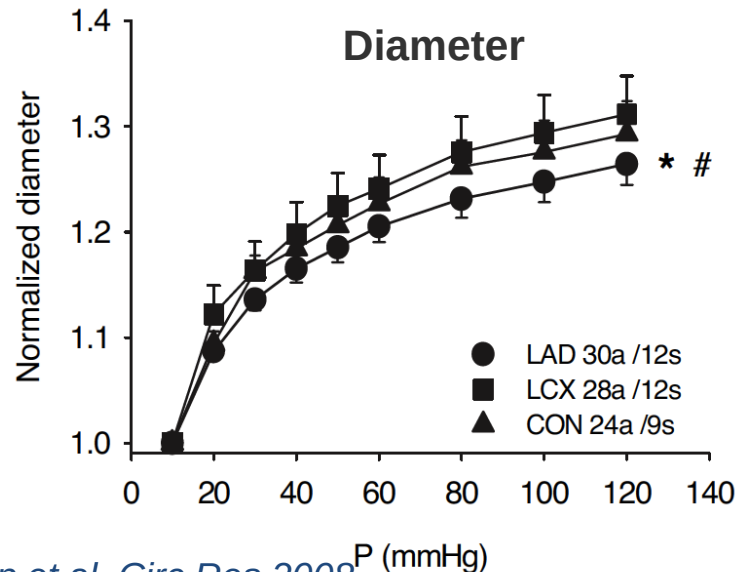


Arterioles (<200 μ m)

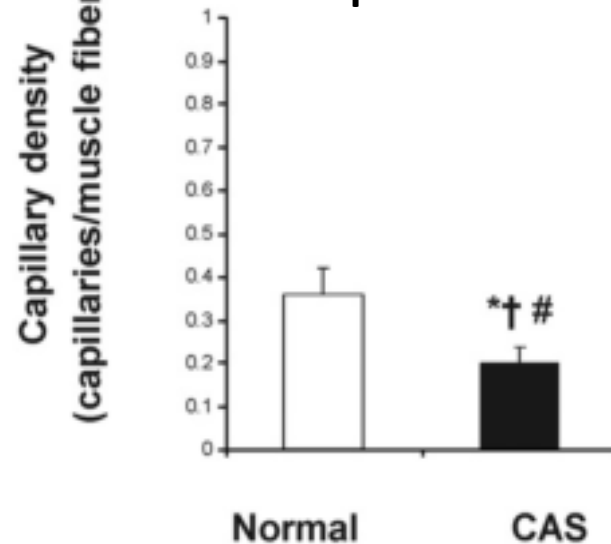


Urbieta et al AJP Heart 2011

Diameter

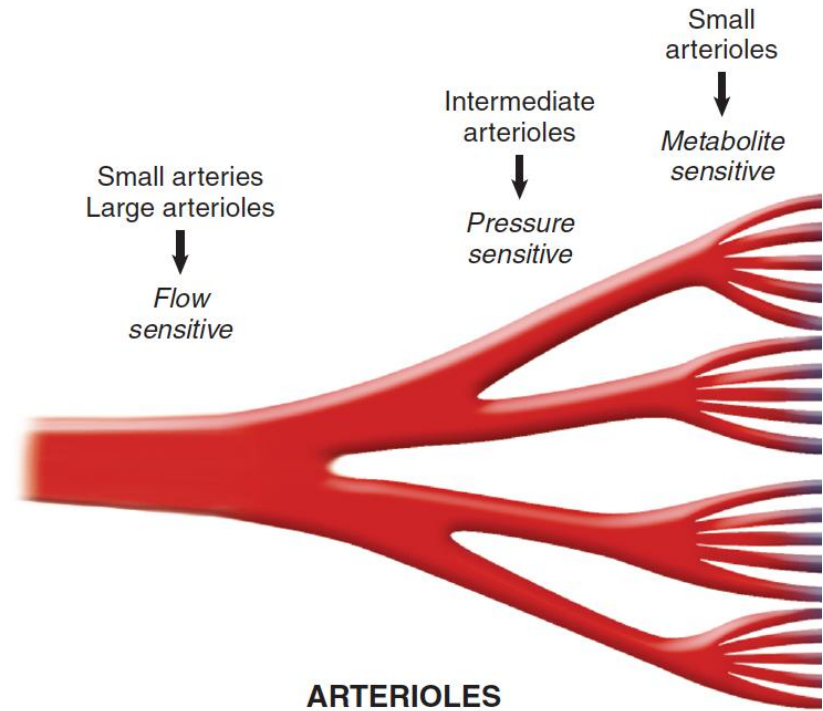
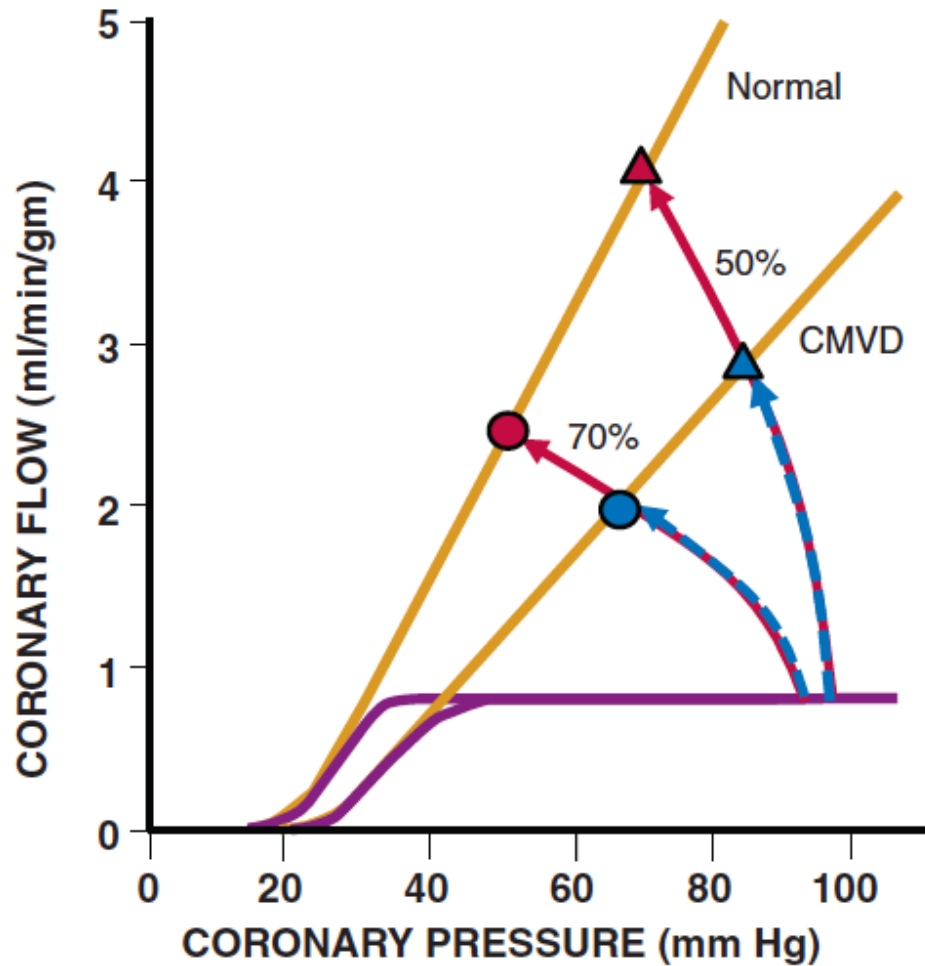


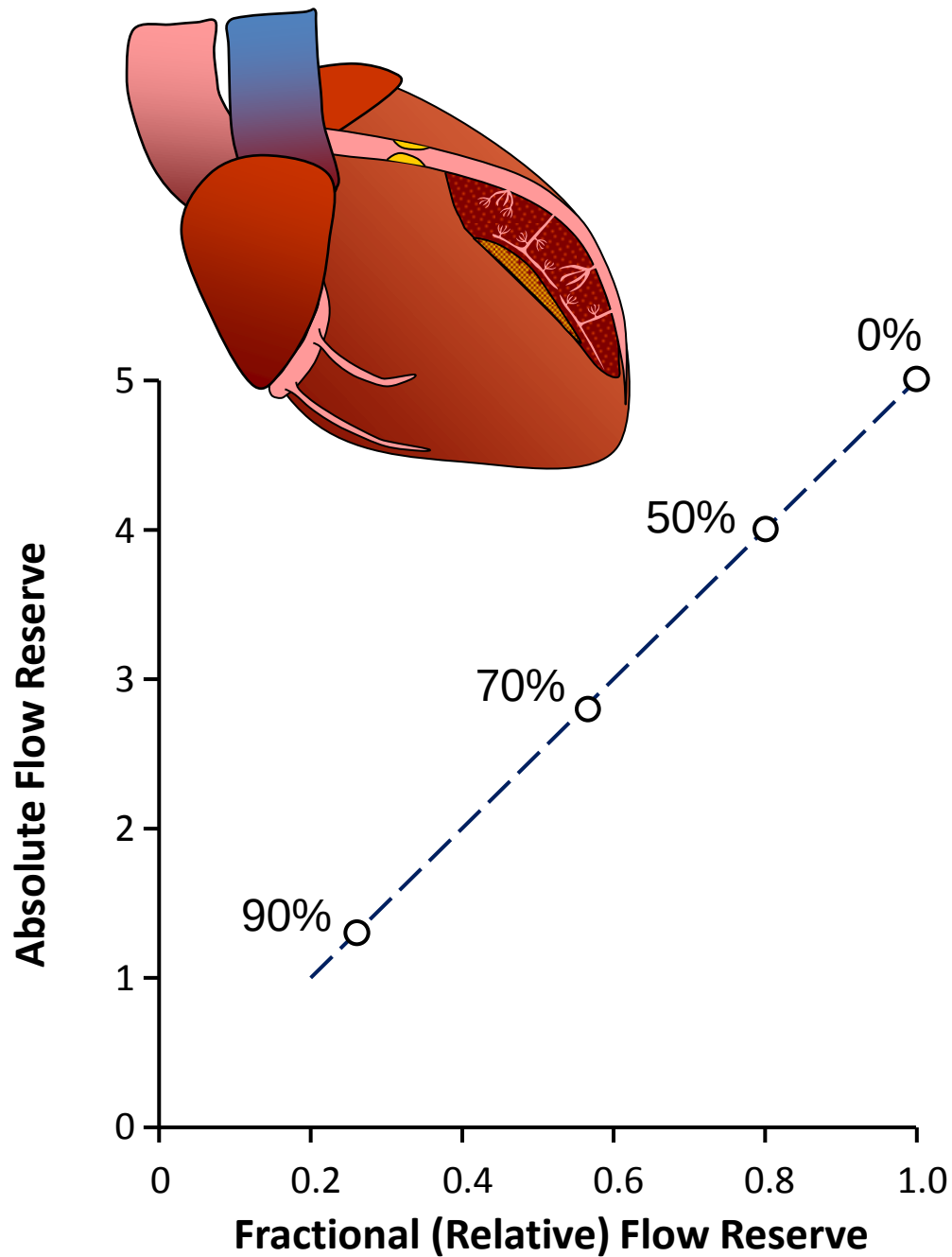
Capillaries



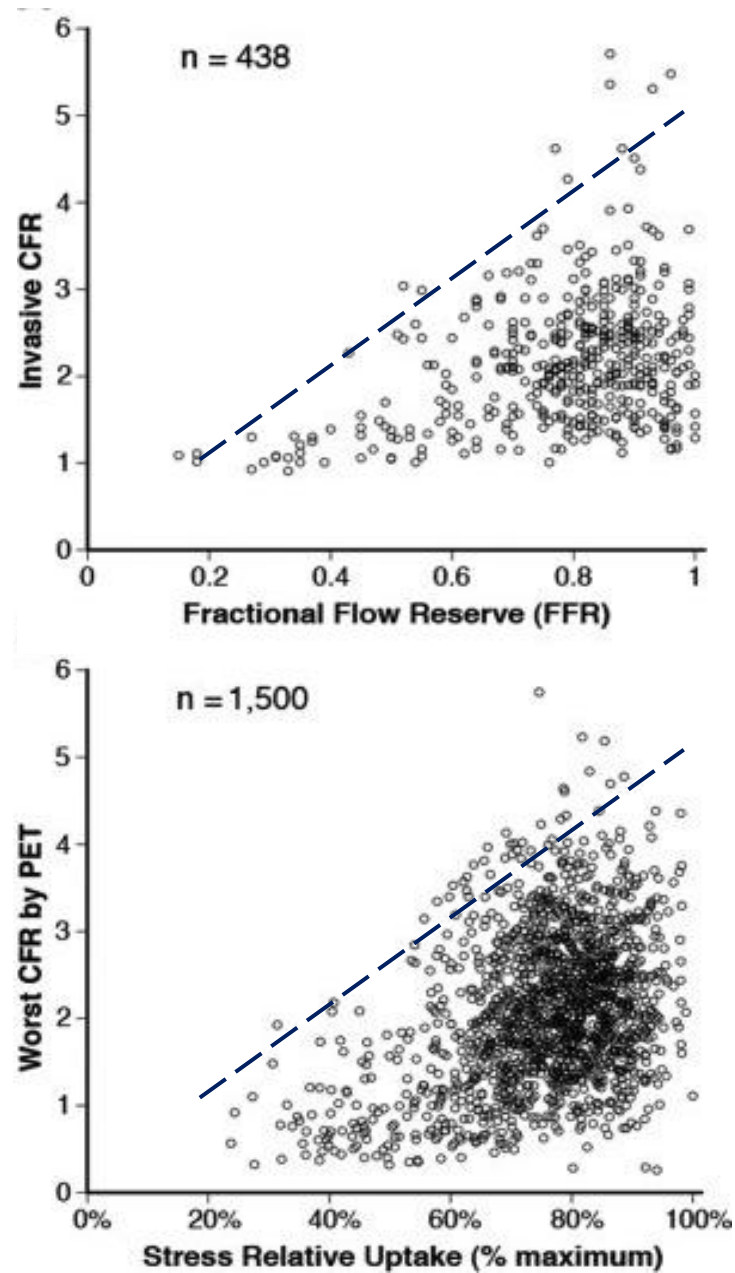
Coronary Pressure-Flow Relation

Influence of Coronary Microvascular Disease





ETP April 24-26, 2014



Johnson et al JACC CV Intervention 2012

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 can aggravate (subendo-) myocardial ischemia (➡ NTG!)
- Functional and structural alterations in small arteries may contribute to myocardial ischemia in patients with coronary artery disease

Duncker & Bache *Pharm Ther* 2000

Duncker & Bache *Physiol Rev* 2008

Canty & Duncker *Braunwald's Heart Disease* 2014