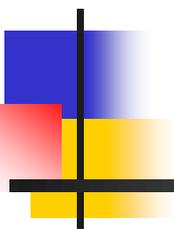
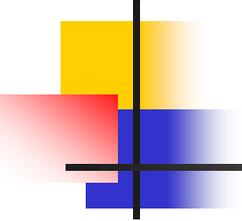


Control of blood tissue blood flow

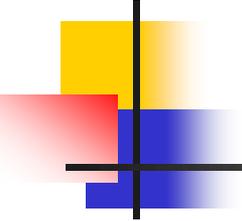


Faisal I. Mohammed, MD,PhD



Objectives

- List factors that affect tissue blood flow.
- Describe the vasodilator and oxygen demand theories.
- Point out the mechanisms of autoregulation.
- Describe how angiogenesis occurs.
- Inter-relat how various humoral factors affect blood flow.



Local Control of Blood Flow

- Each tissue controls its own blood flow in *proportion to its needs*.
- Tissue needs include:
 - 1) delivery of *oxygen* to tissues
 - 2) delivery of *nutrients* such as glucose, amino acids, etc.
 - 3) removal of carbon dioxide hydrogen and other *metabolites* from the tissues
 - 4) transport various *hormones* and other substances to different tissues
- Flow is closely related to *metabolic rate of tissues*.

CARDIAC OUTPUT (L/min/m)

35
30
25
20
15
10
5
0

0 200 400 600 800 1000 1200 1400 1600

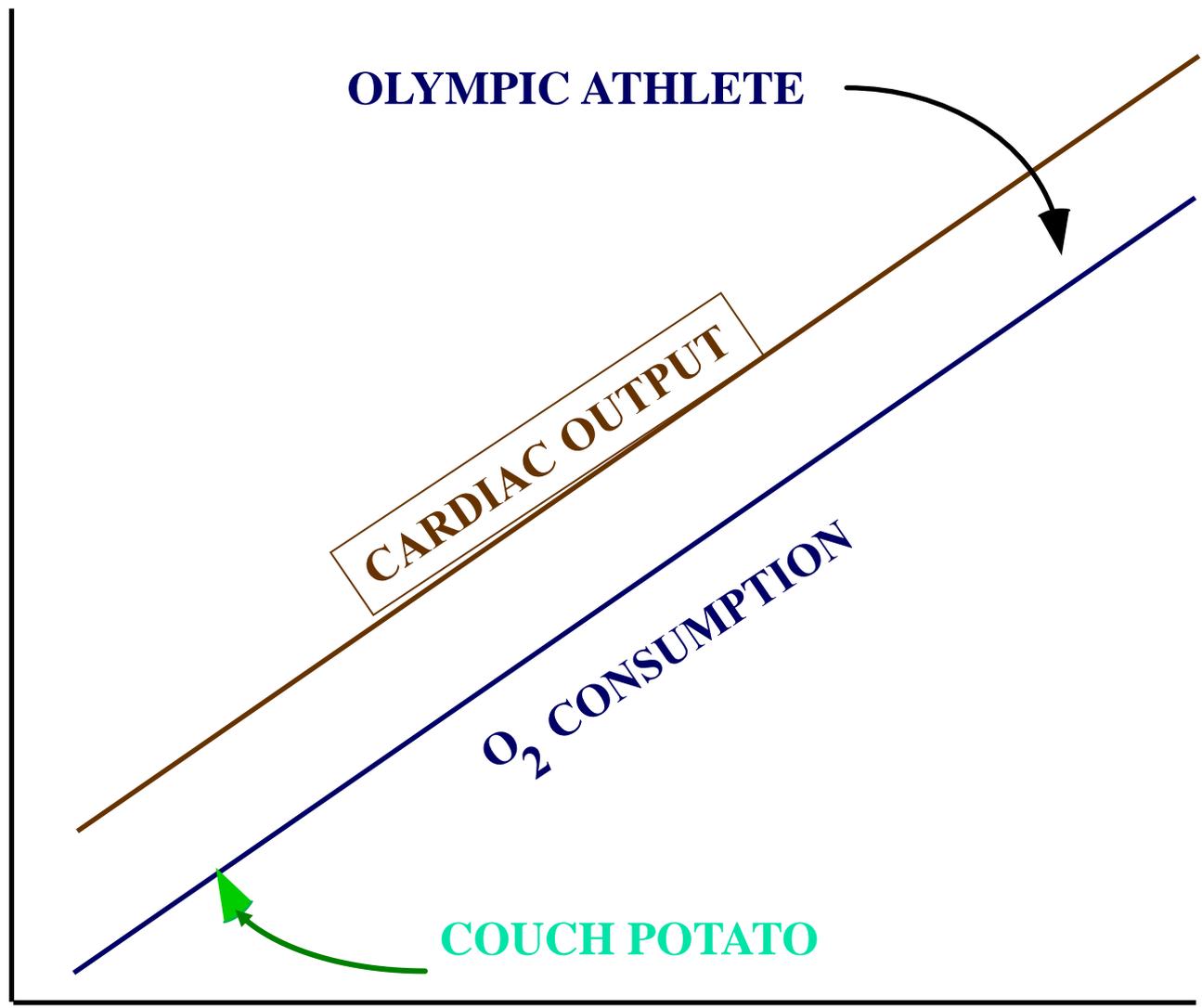
WORK OUTPUT DURING EXERCISE (kg*m/min)

OLYMPIC ATHLETE

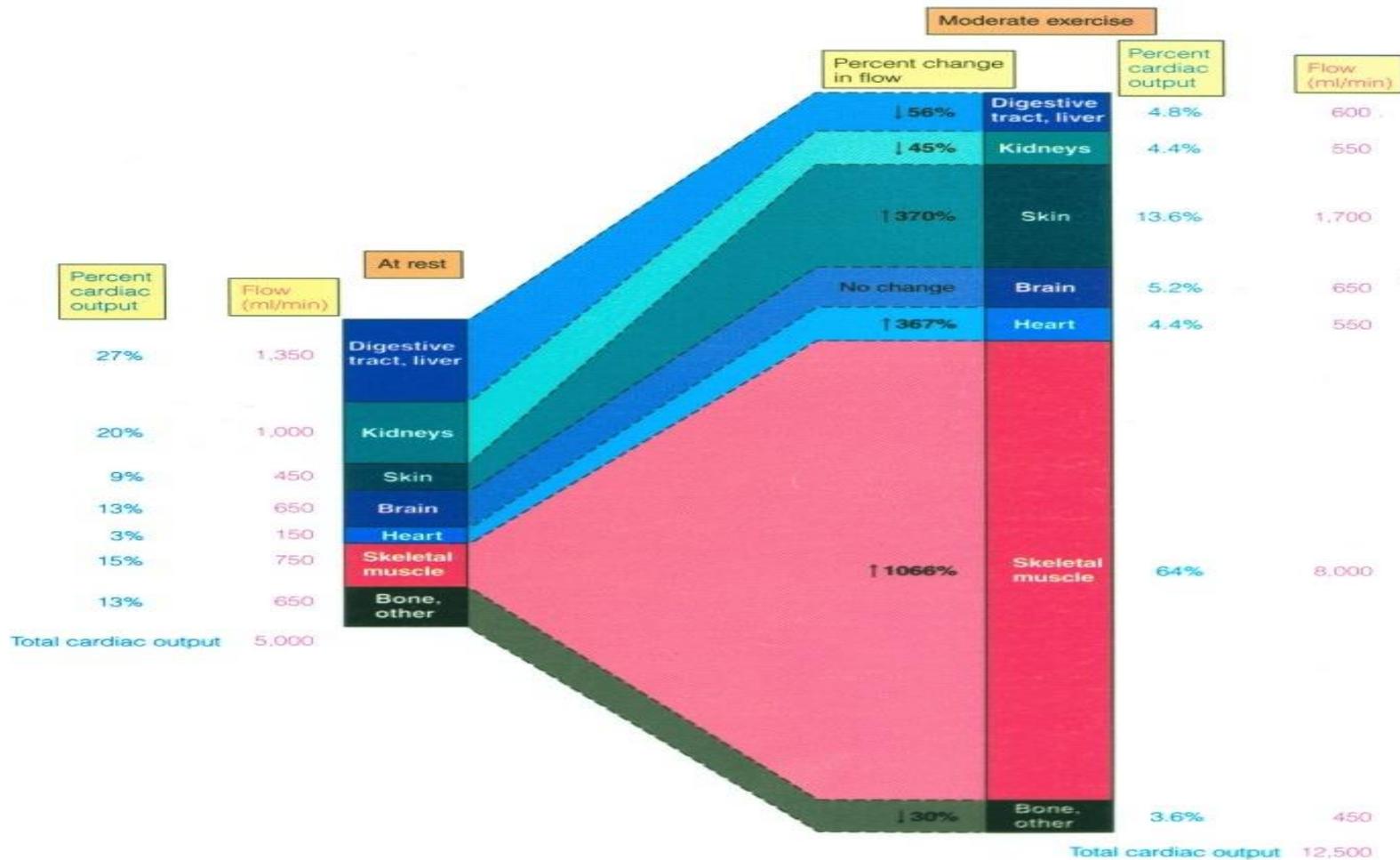
CARDIAC OUTPUT

O₂ CONSUMPTION

COUCH POTATO



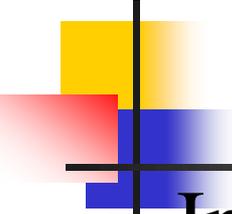
Magnitude & Distribution of CO at Rest & During Moderate Exercise



Variations in Tissue Blood Flow

	Per cent	ml/min	ml/min/ 100 gm
Brain	14	700	50
Heart	4	200	70
Bronchi	2	100	25
Kidneys	22	1100	360
Liver	27	1350	95
Portal	(21)	(1050)	
Arterial	(6)	(300)	
Muscle (inactive state)	15	750	4
Bone	5	250	3
Skin (cool weather)	6	300	3
Thyroid gland	1	50	160
Adrenal glands	0.5	25	300
Other tissues	3.5	175	1.3
Total	100.0	5000	---

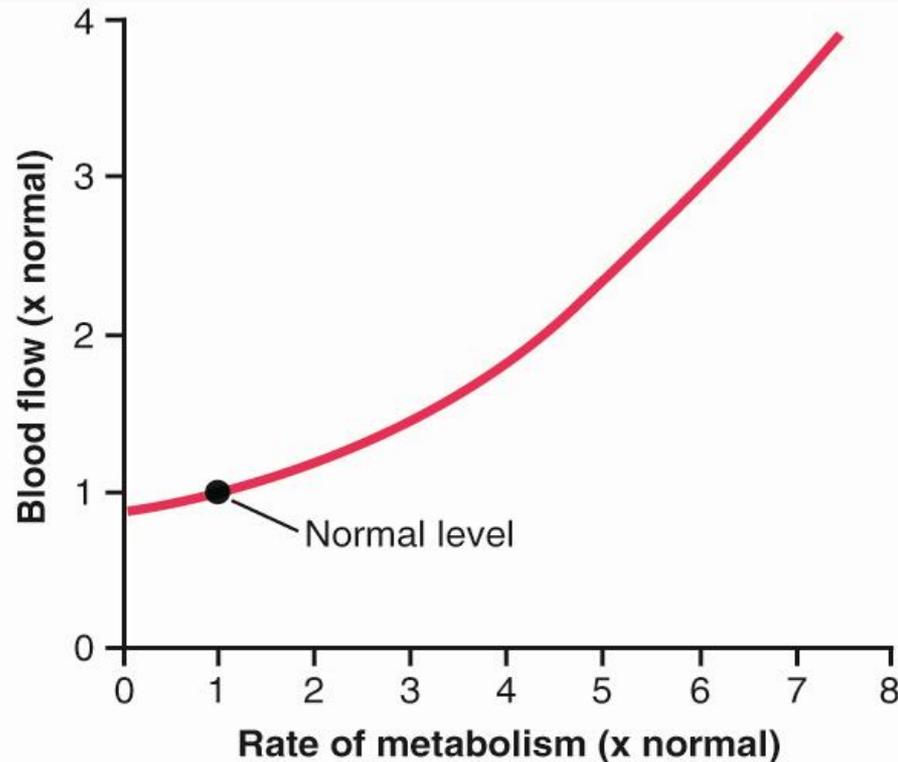
Acute Control of Local Blood Flow



- Increases in *tissue metabolism* lead to increases in blood flow.
- Decreases in *oxygen availability* to tissues increases tissue blood flow.
- Two major theories for local blood flow are:
 - 1) *The vasodilator theory*
 - 2) *Oxygen demand theory*

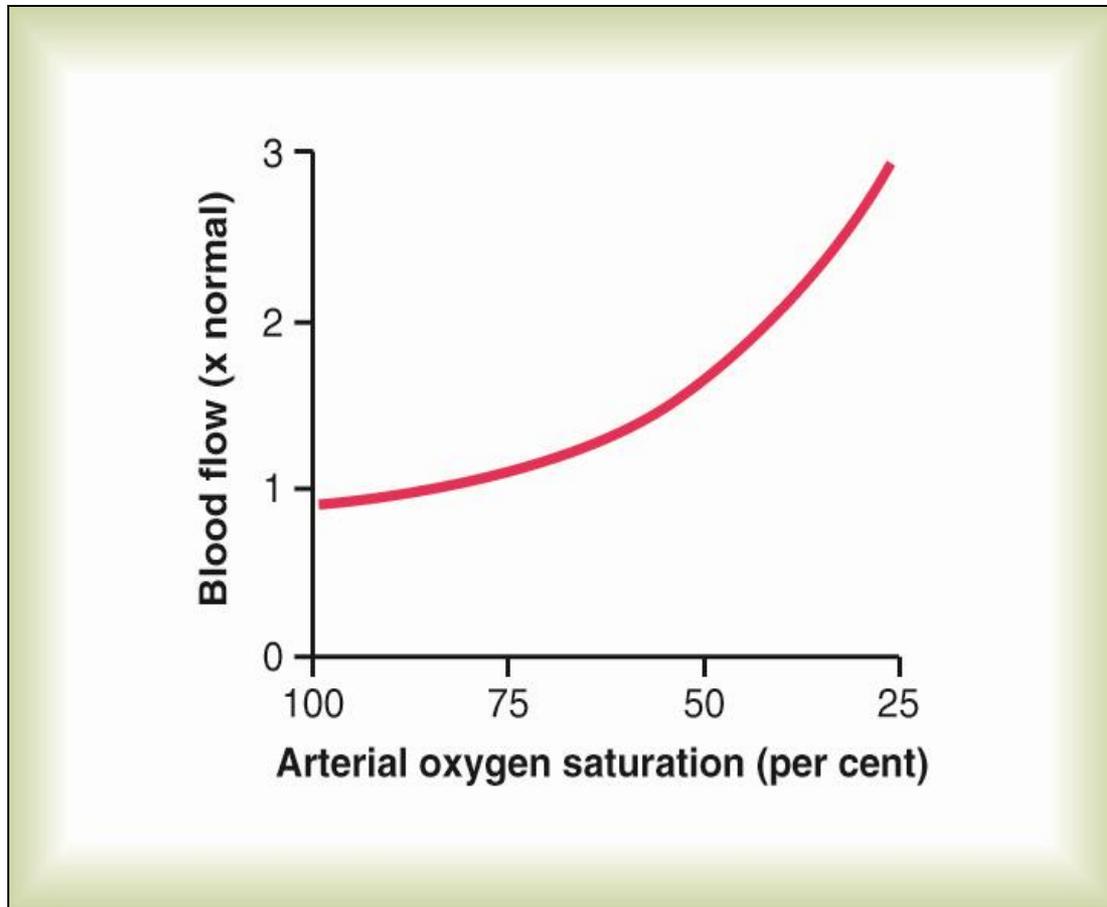
Effect of Tissue Metabolic Rate on Tissue Blood Flow

↑ Tissue Metabolism → ↑ Blood Flow

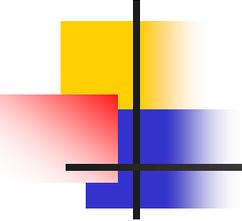


Effect of Tissue Oxygen concentration on Blood Flow

Tissue Oxygen Concentration ← ↑ Blood Flow



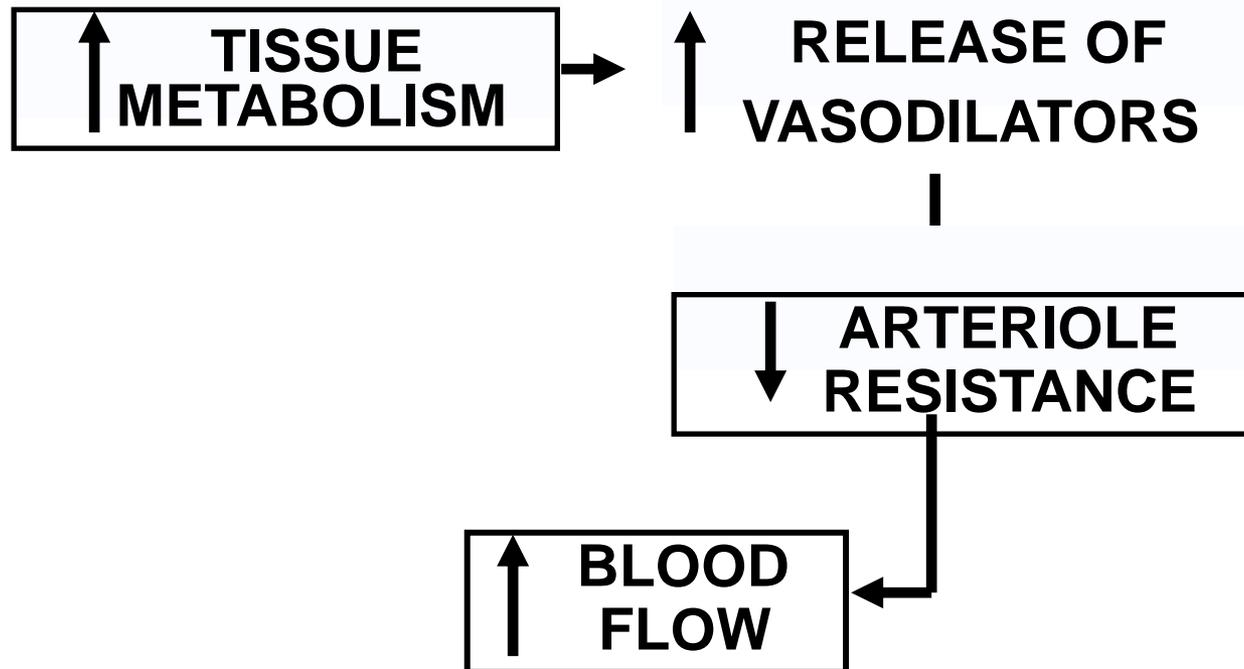
Relationship between Pressure, Flow, and Resistance



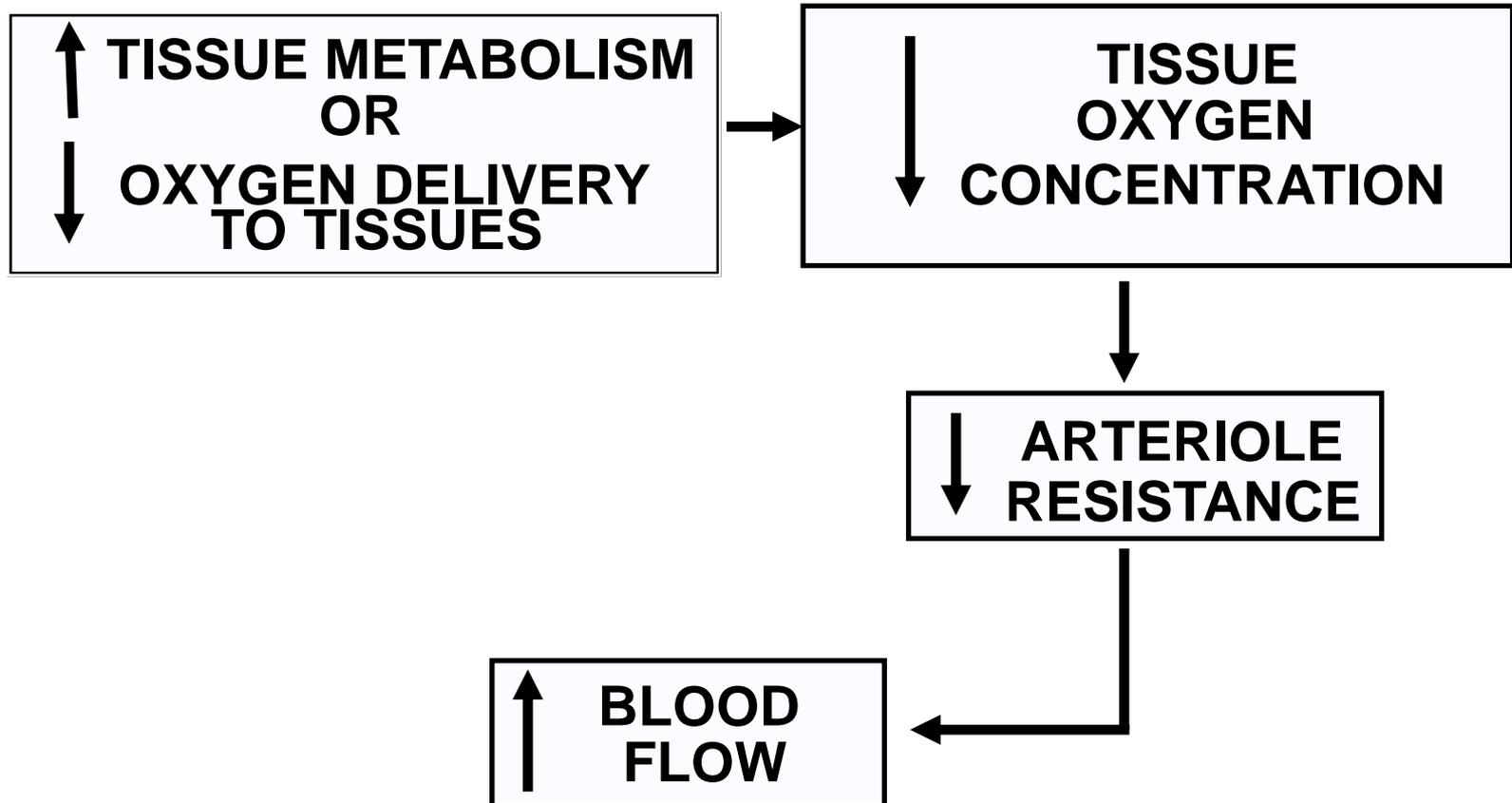
- $F = \Delta P / R$
- *Flow* (F) through a blood vessel is determined by:
 - 1) The *pressure difference* (ΔP) between the two ends of the vessel
 - 2) *Resistance* (R) of the vessel

Vasodilator Theory for Blood Flow Control

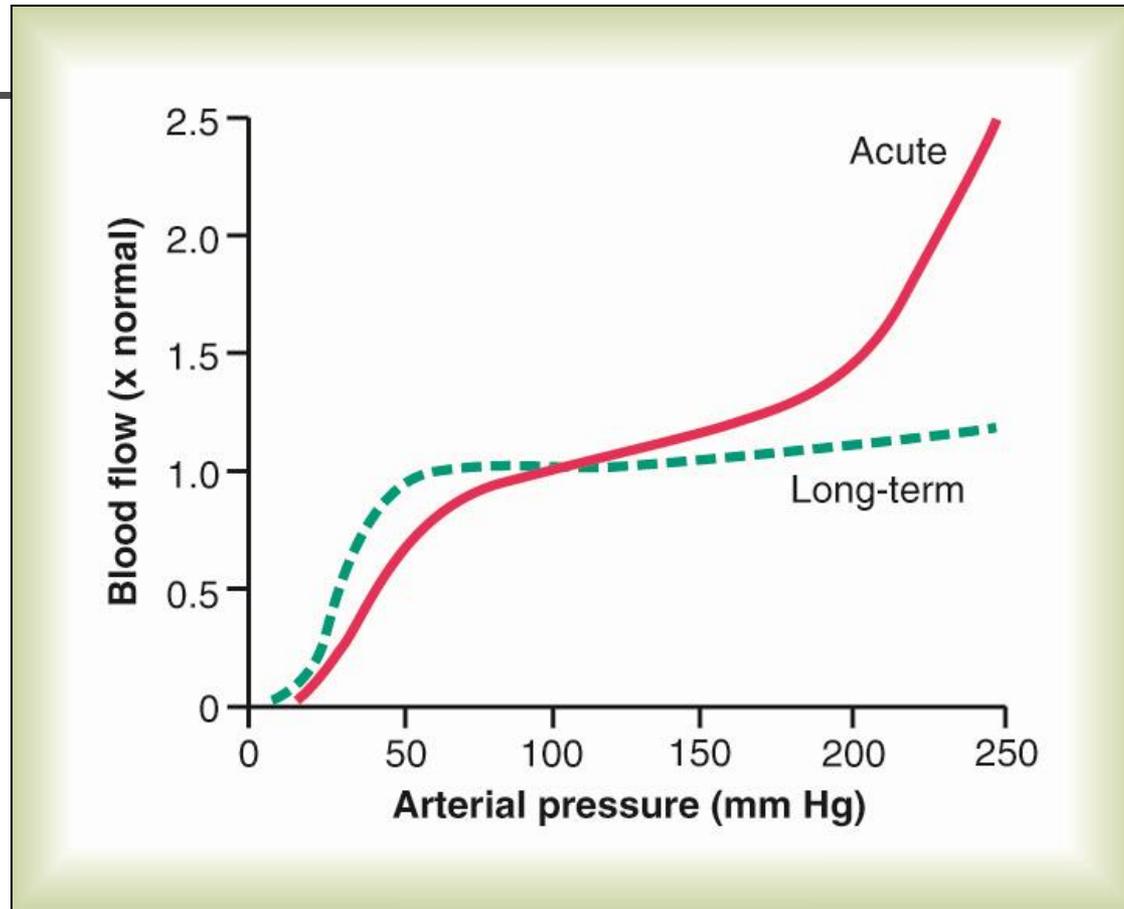
Local Vasodilators: **Adenosine**, **CO₂**, **Lactic acid**, **ADP compounds**, **Histamine**, **K⁺ ions**, **H⁺ ions**, **Prostacyclin**, **Bradykinin**, and **Nitrous oxid (NO)**



Oxygen Demand Theory for Blood Flow Control

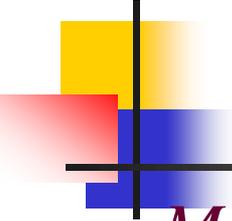


Autoregulation of Blood Flow



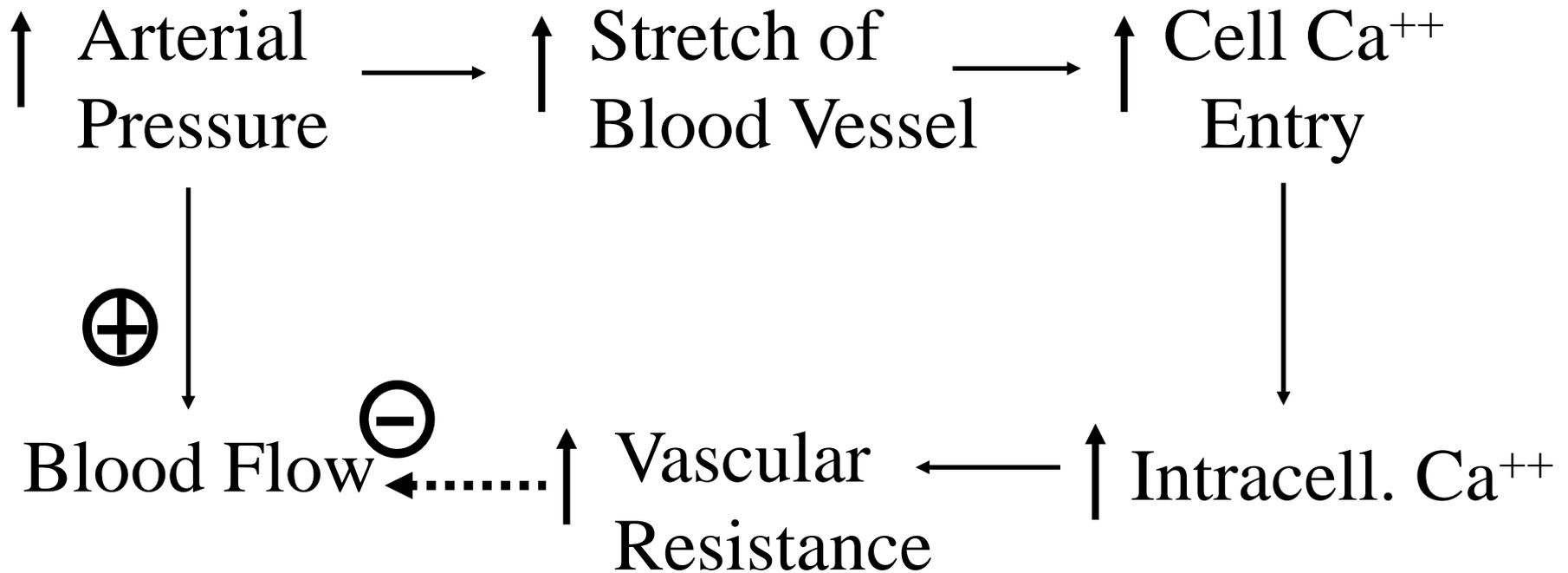
Autoregulation - ability of a tissue to maintain blood flow relatively constant over a wide range of arterial pressures.

Blood Flow Autoregulation Theories

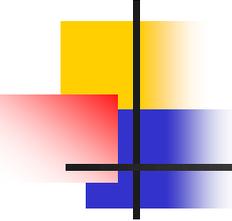


- *Metabolic theory* suggests that as arterial pressure is decreased, oxygen or nutrient delivery is decreased resulting in release of a vasodilator.
- *Myogenic theory* proposes that as arterial pressure falls the arterioles have an intrinsic property to dilate in response to decreases in wall tension.
- Certain tissues have *other mechanisms* for blood flow control the kidneys have a feedback system between the tubules and arterioles and the brain blood flow is controlled by carbon dioxide and hydrogen ion conc.

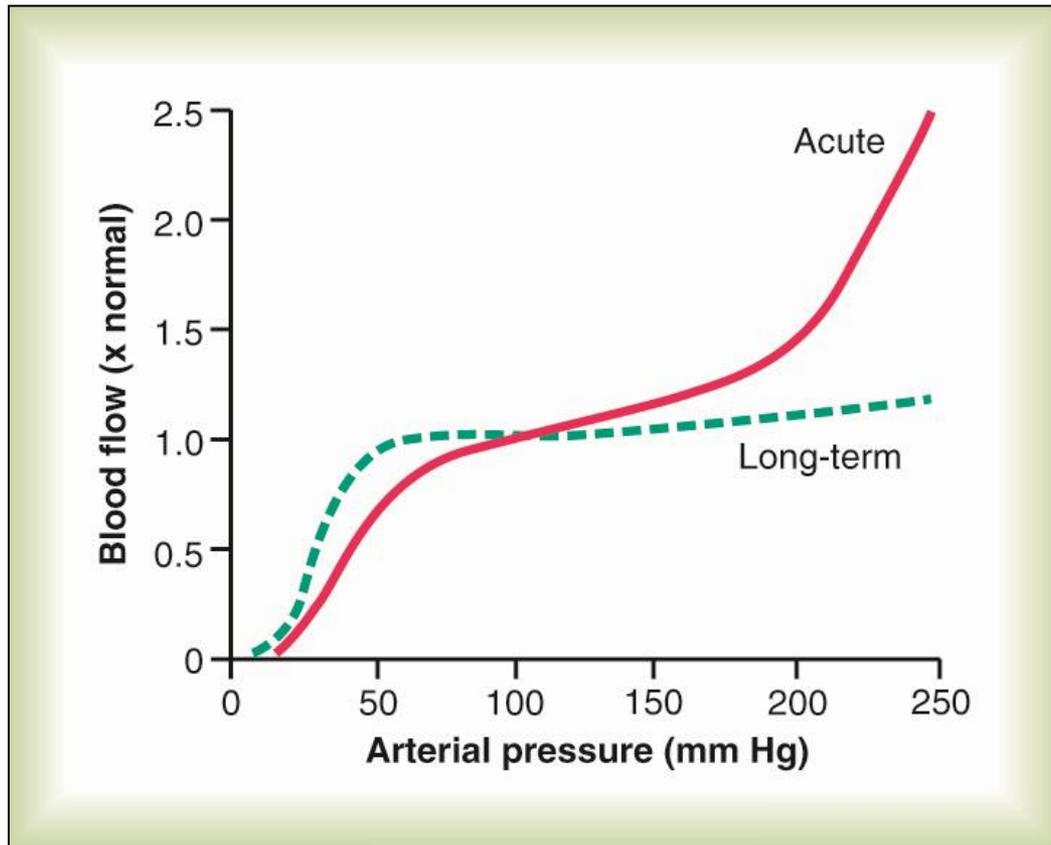
Myogenic Mechanism

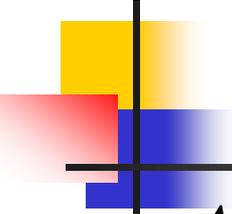


Long-term Regulation of Blood Flow

- 
- Long-term regulatory mechanisms which control blood flow are more effective than acute mechanism.
 - Long-term local blood flow regulation occurs by changing the degree of vascularity of tissues (*size and number of vessels*).
 - *Oxygen* is an important stimulus for regulating tissue vascularity.

Long-term Regulation of Blood Flow

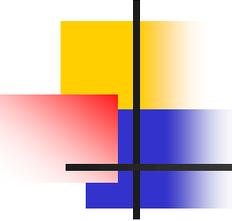




Angiogenesis

- *Angiogenesis* is the growth of new blood vessels.
- Angiogenesis occurs in response to angiogenic factors released from:
 - 1) ischemic tissue
 - 2) rapidly growing tissue
 - 3) tissue with high metabolic rates
- Most angiogenic factors are *small peptides* such as vascular endothelial cell growth factors (**VEGF**), fibroblast growth factor (**FGF**), and **angiogen**.
- Example of angiogenesis is *Retrolental Hyperplasia*

Humoral Regulation of Blood Flow



- Vasoconstrictors

Norepinephrine and epinephrine

Angiotensin

Vasopressin

Endothelin

- Vasodilator agents

Bradykinin

Serotonin

Histamine

Prostaglandins

Nitric oxide

Thank You

