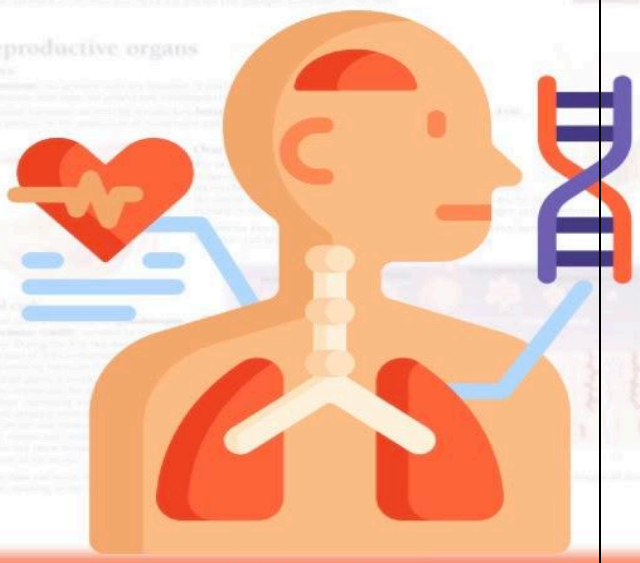
Doctor 022

Physiology

Sheet no.



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بسم الله الرحمن الرحيم

كلام الدكتورة بالأزرق والسلايدات بالأسود و العناوين بالأحمر

Local and Humoral Control of Tissue Blood flow

First of all the objectives of this chapter :

1. Know what factors affect tissue blood flow
2. Describe the vasodilator and oxygen demand theories
3. Know mechanisms of autoregulation
4. Describe how angiogenesis occurs
5. Know how various humoral factors affect blood flow

1. Local Control of Blood Flow

Each tissue controls its own blood flow(and not by the heart or blood pressure which have a separate regulatory mechanism) in **proportion to its needs** which is a very important feature of tissues .

Tissue needs include

A) Delivery of oxygen to tissues (most important function of the cardiovascular system -CVS-)

B) Delivery of nutrients such as glucose, amino acids, etc.

C) Removal of carbon dioxide hydrogen and other metabolites (waste product) from the tissues.

D) Transport various hormones and other substances to different tissues

So if the tissue needs more oxygen or nutrients (high metabolic activity) then the blood flow would be high , but if the metabolic activity is low then the blood flow would be low.

A golden rule that we need to know :

Flow is closely related to metabolic rate of tissues.

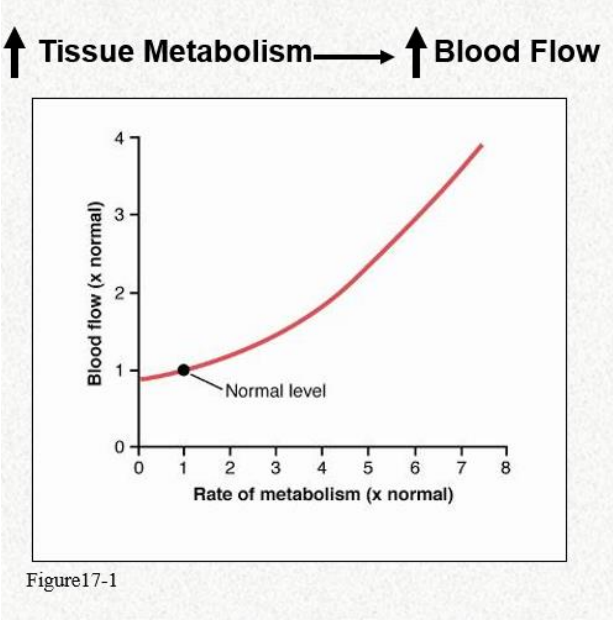

Figure17-1

2 . 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)	1	5750	4
Bone	5	250	3
Skin (cool weather)	6	300	3
Thyroid gland	1	50	160
Adrenal glands	0	.525	300
Other tissues	3.5	175	1.3
Total	100.0	5000	--

**heart refers to the muscles of the heart*

**the "per cent" column is the blood flow of the tissue percentage of the total cardiac output or blood flow*

So for example can we say that the brain blood flow is higher than the adrenal gland's blood flow according to the first two columns ??

-the answer is NO because each organ weighs differently than the other.

So if we want to compare the blood flow between different organs we need to use a unified unit of measurement by dividing the blood flow of the organ by the mass of that organ so we would get the third column which is the blood flow per 100 grams of that organ (pay attention to the units!!)

Notice that the kidneys,liver,thyroid gland, and the adrenal gland have the highest blood flow (third column), is it because they need higher supply (more metabolically active)??

The answer to the previous question is NO. it is caused by the fact that the function of these tissues need the higher blood flow to function efficiently , for example the kidney and the liver filter the blood , and the glands produce hormones

-also the same tissue can get different blood flow, like the muscles get a lower blood flow when inactive than when they are active

-there are other conditions that might affect the blood flow of a specific tissue like the weather (the skin gets a lower blood flow when the weather is cold)

The main take away from all of that is that not all organs get the same blood flow

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3 . Acute Control of Local Blood Flow

-How does the control of flow occur ? they noticed experimentally that Increase in tissue metabolism lead to increase in blood flow (a direct relationship in a specific tissue) for example they took a relaxed muscle cell and measured the blood flow then they contracted the cell and measured the blood flow a second time and found out that the blood flow when the cell is contracted is 2 or 3 times higher than when it is relaxed

Two major theories for local blood flow are

a) The vasodilator theory (metabolites vasodilate the blood vessels -> higher blood flow)

b) Oxygen demand theory

- Decreases in oxygen availability to tissues increases tissue blood flow (when there isn't enough oxygen for smooth muscle cells of the arterioles to contract)

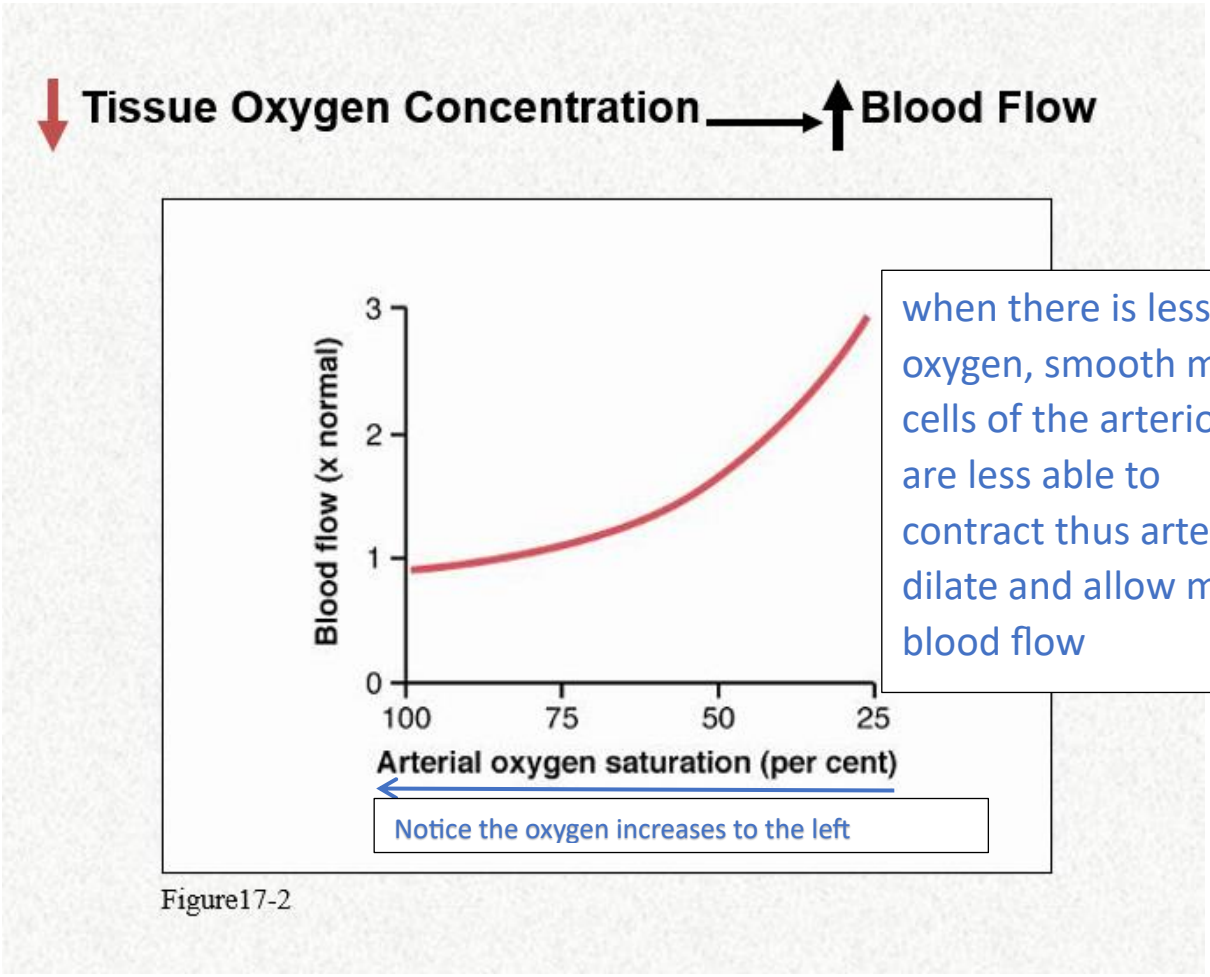


Figure17-2

4 . Relationship Between Pressure, Flow, and Resistance

Ohms law :

Q=ΔP/R

Flow (Q) through a blood vessel is determined by:

1) The pressure difference (in the capillaries) (ΔP) between the two ends of the vessel $Q \propto \Delta P$

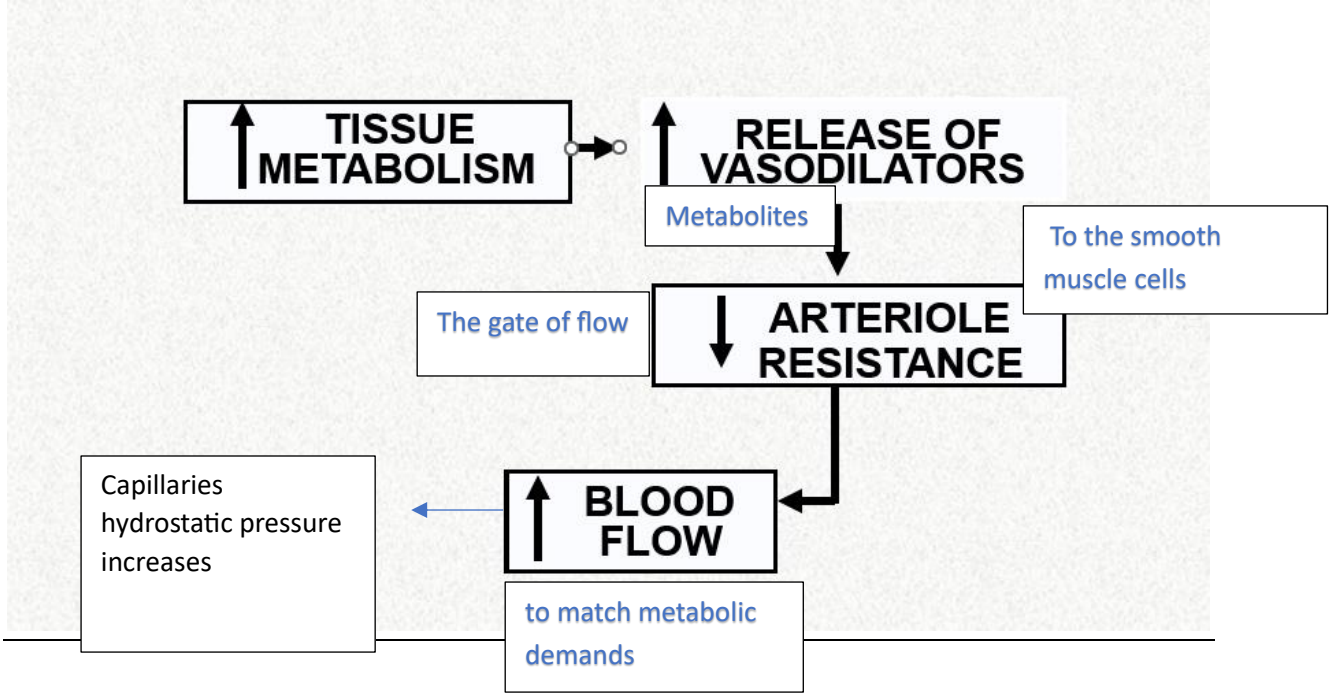
2) Resistance (R) of the vessel $Q \propto 1/R$

The doctor said the previous isn't really that important but what is more important is to know that the hydrostatic pressure in the capillaries is controlled by the resistance in the arterioles

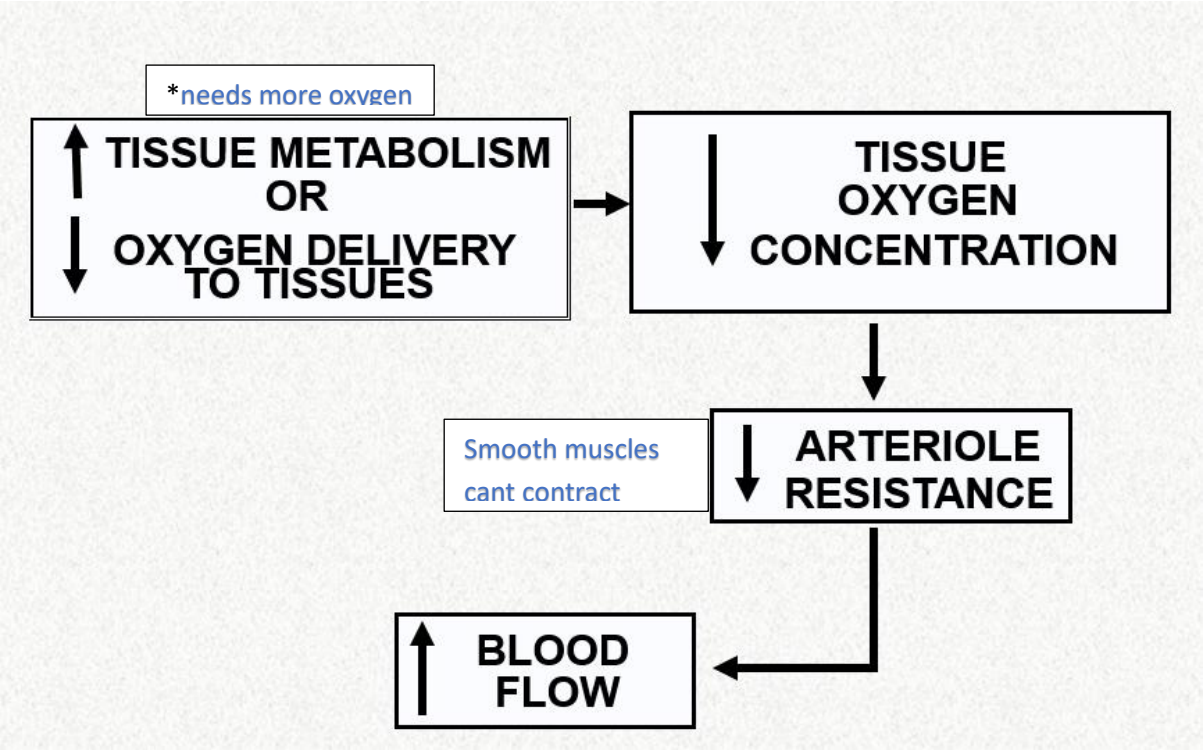
(when the resistance decreases the hydrostatic pressure of the capillaries increases because more blood has reached the capillaries)

5 . Vasodilator Theory for Blood Flow Control

Vasodilators: Adenosine, CO2, Lactic acid, ADP compounds Histamine, K ions, H ions



6 . Oxygen Demand Theory for Blood Flow Control



7 . Autoregulation of Blood Flow

It is automatic regulation

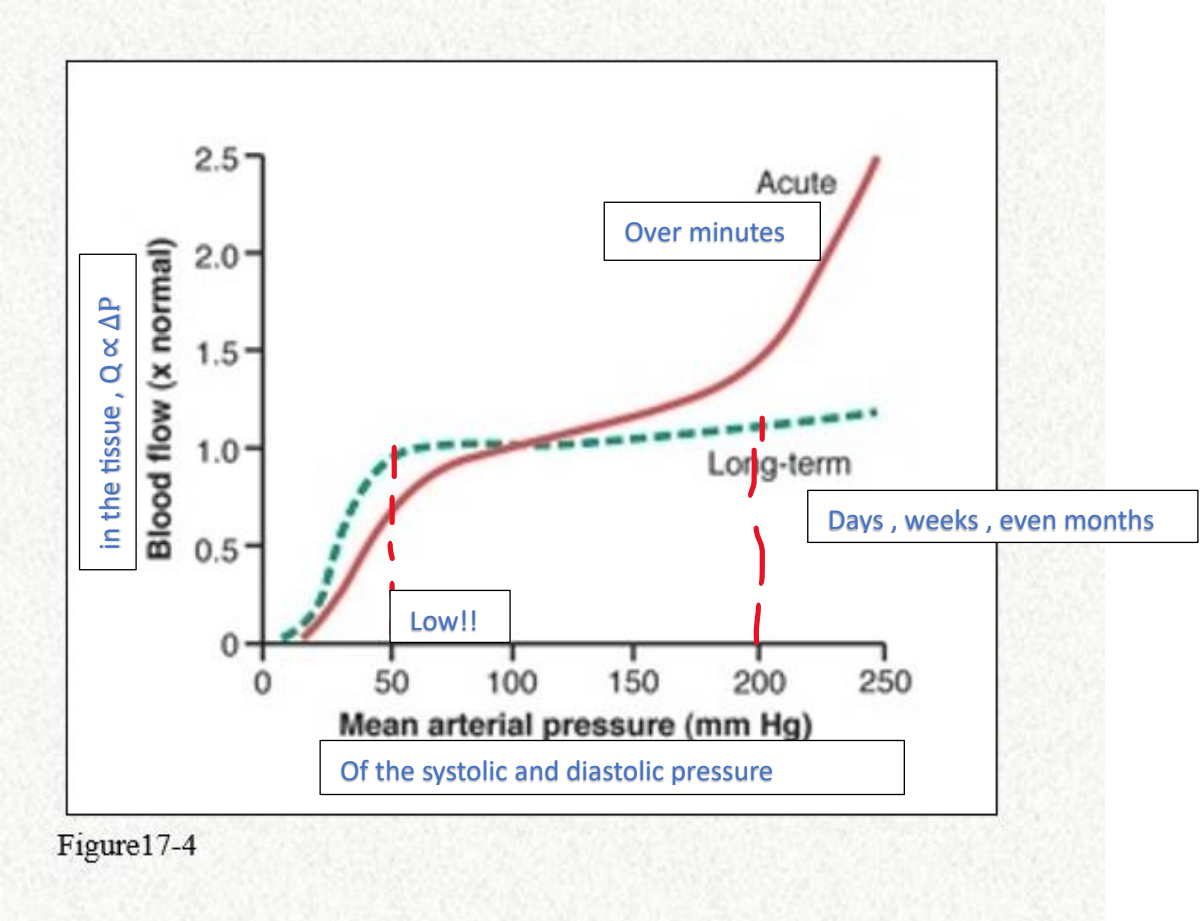


Figure17-4

*note : systolic pressure – the pressure when your heart pushes blood out.

diastolic pressure – the pressure when your heart rests between beats.

We have two curves, the long-term one has much better resistance to change (the arterial blood flow doesn't change , the blood flow is almost constant in the interval [50 mmHg , 180-200 mm Hg])

Autoregulation(from the arterioles) - Ability of a tissue to maintain blood flow relatively constant over a wide range of arterial pressures

(fixes the blood flow over different pressures)

-notice that even over acute changes at 50- 200 mm hg there is good fixation

8 . Autoregulation of Blood Flow

Metabolic theory: suggests that as arterial pressure is decreased, oxygen or nutrient delivery is decreased resulting in release of a **vasodilator**

Myogenic theory (mechanism of autoregulation, myogenic refers to smooth muscle cells , and the theory is related to laplace's law) proposes that as arterial pressure falls the arterioles have an intrinsic property to dilate in response to decreases in wall tension or when arterial pressure increases , the arterioles contract with no need for any signal of a nerve.

Certain tissues have other mechanisms (autoregulation) 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 concentration

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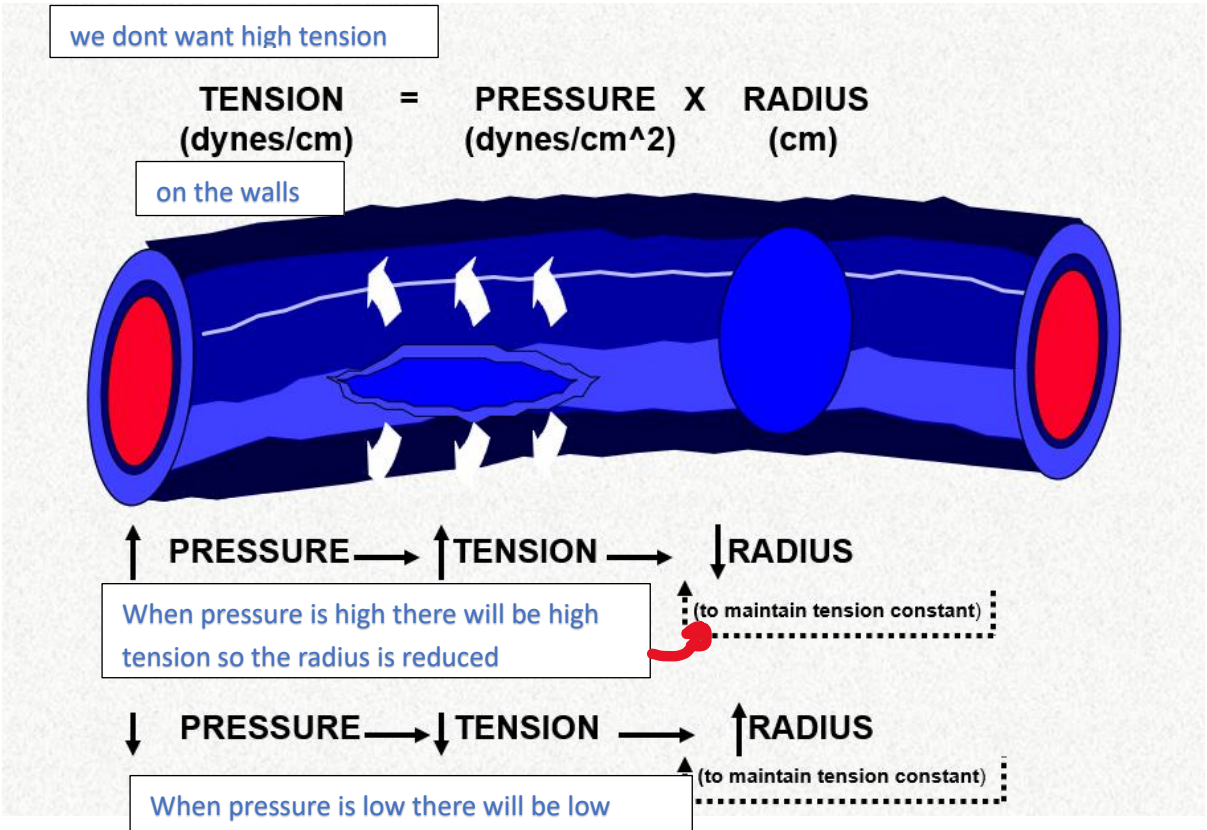
9 . Laplace's Law: Myogenic mechanism



10 . Long-term Regulation of Blood Flow

Long-term regulatory mechanisms which control blood flow are more effective than acute mechanism , and long term regulatory mechanisms maintain constant blood flow even if there were fluctuations in the systemic blood pressure.

Long-term local blood flow regulation occurs by changing the degree of vascularity of tissues (size and number of vessels) so over the course of days and months some changes occur to the structure of the vessels , these changes are permanent.

Oxygen is an important stimulus for regulating tissue vascularity , especially the number of vessels (more demand for oxygen => more vascularization to provide more oxygen to the tissue) .

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11 . Angiogenesis

Angiogenesis is the growth of new blood vessels and it accurs in response to angiogenic factors released from :

A. Ischemic Tissue (lacks oxygen or nutrition)
B. Rapidly growing tissue
C. Tissue with high metabolic rates

Most angiogenic factors are small peptides (they are local factors) such as:

1.Vascular endothelial cell growth factors (VEGF)

2.fibroblast growth factor (FGF)

3.angiogen

Angiogenesis is an example of long term auto regulation .

12 . Humoral Regulation of Blood Flow: Acute

in the long run, these acute regulation factors will cause long term regulation or changes

A. Vasoconstrictors (they cause constriction of blood vessels)**:**

1.Norepinephrine and epinephrine (sympathetic stimulation)

2.Angiotensin

3.Vasopressin

4.Endothelin

B.Vasodilator agents (they cause dilation of blood vessels) :

1. Bradykinin
2. Serotonin
3. Histamine
4. Prostaglandins
5. Nitric oxide

Both vasoconstrictors and vasodilators could be released for different reasons.

تم بحمد الله

V2: We added 2 topics that mentioned in the complementary video that doctor sent on Teams
The topics are :
11)Angiogenesis (page10)
12)humoral regulation of blood flow (page 11)