

Circulation Lab

IB Biology

Name: MR KEE

Mark: _____

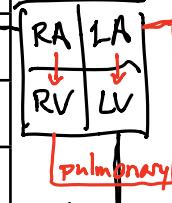
A. Blood Vessels

- On your fetal pig, identify the following blood vessels, and observe where they go to and from. *Do not cut out the heart!* Fill out the table completely. (5)

Name	Going To	Coming From	Oxy. / Deoxy.	Nutrients / Wastes
Carotid artery	head	aorta	oxy	
Jugular vein	ant. v. c.	head	deoxy	
Subclavian artery	arms	aorta		
Subclavian vein	ant. v. c.	arms		
Anterior vena cava	right atrium	upper body		
Posterior vena cava	right atrium	lower body		
Pulmonary artery	lungs	right vent.	deoxy	
Pulmonary vein	left atrium	lungs	oxy	
Coronary artery	heart	aorta		
Coronary vein	post. v.c.	heart		
Aorta	systemic circ.	left ventricle		
Hepatic artery	liver	aorta		
Hepatic vein	post. v.c.	liver		
Hepatic portal vein	liver	sm. intestine		NUTRIENTS
Mesenteric artery	sm. intestine	aorta		
Renal artery	kidney	aorta		
Renal vein	post. v.c.	kidney		
Iliac artery	legs	aorta		

pulmonary

Systemic



Name	Going To	Coming From	Oxy. / Deoxy.	Nutrients / Wastes
Iliac vein	post. v.c.	legs		
* Umbilical artery	placenta	iliac artery	DEOXY	WASTE
* Umbilical vein	liver	placenta	OXY	NUTRIENTS

2. There are large blood vessels which leave the heart called arteries.

These branch into many smaller blood vessels called arterioles, which branch into very tiny blood vessels called capillaries. These are now small enough to transport materials to the cells. Wastes from the cells diffuse into the same type of blood vessels called capillaries. These tiny blood vessels join to form larger venules which join to form even larger blood vessels called veins. These return blood to the heart. (3)

3. a) What is the correct definition for *arteries*? (1)

- carry blood away from heart to capillaries.
 ↑
 HIGH PRESSURE

b) Arteries do not always carry oxygenated blood. Name one artery that carries de-oxygenated blood. Where is this artery carrying deoxygenated blood to? (1)

pulmonary / umbilical
 ↳ lungs ↳ placenta

3. a) What is the correct definition for *veins*? (1)

- carry blood towards heart from capillaries
 ↓
 low pressure

b) Veins sometimes carry oxygenated blood. Name one such vein. Where is this vein coming from? Where is this vein carrying oxygenated blood going? (1)

pulmonary / umbilical

4. a) Through which blood vessels does transfer of materials occur to and from cells? (1)

capillaries

- b) How many cells thick are these blood vessels? This makes diffusion faster. (1)
1.
 $\sim 10 \mu\text{m}$ diameter

- c) List 2 substances that are necessary for aerobic respiration that filter into the cells. (1)

glucose + O₂

- d) List 2 waste products that diffuse out of the cells. (1)

CO₂, H₂O, nitrogenous wastes

- e) What structures present around these vessels regulate blood flow? (1)

sphincters

5. Artery walls are so thick, they have their own blood vessels that supply blood to the arterial cells. Why must arteries have such thick, strong walls? (1)

high pressure; also provides secondary "pumping"

6. Name the 2 types of tissue found in the very thick middle layer of arteries and give their functions. (2)

- i. muscle → allow contraction / regulate B.P.
ii. elastic

7. a) Veins also have 3 layers of cells but are much thinner. Why do veins not need thick strong walls like arteries? (1)

bw pressure

- b) What is found in veins to allow blood to flow back to the heart even when we are standing? Varicose veins are a malfunction of these structures. (1)

valves

8. Distinguish between

- a) pulmonary circulation (1)

right vent → pulm art. → lungs → pulm vein →
left atrium

- b) systemic circulation (1)

left vent → aorta → rest of body → vena cava
→ right atrium

B. Blood

9. If blood is spun in a centrifuge, it separates into 2 main layers. (4)

- Name the upper layer: **plasma**
- What % of the total blood volume is this layer? **60%**
- Name the lower layer: **formed elements**
- What % does it make up? **40%**

10. Fill in the chart with the various component parts of blood: (3)

Component of Blood	Function	Source
1 water	Solvent / carrier	large intestine (diet)
2 protein	nutrients, enzymes, antibodies clotting, hormones, osmotic pressure	sm int, liver
3 nitrogenous wastes	→	body cells / liver
4 salts	osmotic pressure	sm. int.
5 sugar	provides E to cells	sm. int. / liver
6 lipids	hormones, E	" " / adipose
(N ₂) 7 gases O ₂ , CO ₂	cellular resp. .	lungs / body cells
1 erythrocytes (RBC)	carrying O ₂ / CO ₂	bone marrow
2 leucocytes (WBC)	immune response	bone marrow
3 platelets	clotting	" "

All of these components are involved in maintaining *homeostasis*. The three major categories of functions are:

- transport
- clotting
- infection fighting

C. Transport

11. Fill in the chart. Nitrogenous wastes and nutrients will go to one place first before being transported to the final destination. (4)

Substance	Part of Blood	From	To	To
O ₂	RBC (plasma)	lungs	somatic cells	
CO ₂ $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HCO}_3^- + \text{H}^+$	RBC plasma	somatic cells	lungs	Carbonic anhydrase
Nitrogenous wastes	plasma	" "	<u>LIVER</u>	kidney
Nutrients	plasma	sm int	<u>LIVER</u>	somatic cells

12. Hormones, vitamins, fatty acids and other large molecules are transported in combination with the blood proteins (albumins, globulins, fibrinogen). Which part of the blood transports these large molecules? (1)

plasma

13. a) What is the major function of red blood cells (erythrocytes)? (1)

carrying O₂ + CO₂

- b) What protein molecules found in RBCs carry on this vital function? (1)

hemoglobin

- c) What metallic ion is found in these protein molecules? O₂ is attached to this ion.

(1) Fe³⁺

- d) When this protein and ion pick up O₂ in the lungs, the blood turns bright red.

What is the name of this complex? (1)

Oxy hemoglobin

- e) Write out the equation for the reaction which occurs with this protein and O₂ in the lungs. (1)



- f) What is the chemical complex called after it has released O₂ to the tissues? (1)

deoxy hemoglobin

- g) Write out the equation for this reaction which occurs in the venous capillaries. (1)



D. Red blood cells (erythrocytes)

14. How many RBCs are there per mL of blood? (1)

a lot ~ 5 million

15. Draw a side view and top view of an erythrocyte. (1)



16. Where are RBCs made? (They last for about 120 days) (1)

red bone marrow

17. When *mature*, what is missing from a red blood cell? (1)

nucleus

18. Explain what triggers off an increased production of RBCs? (1)

low O₂ → kidneys produce erythropoietin → produce more RBC

19. a) Where are RBCs broken down and recycled? (1)

LIVER

b) What happens to the Fe⁺³? (1)

→ store in LIVER → transfer to bone marrow.

c) What happens to the heme portion? (1)

→ bilirubin → bile salts

20. Why does anemia result in a tired, run-down feeling? (1)

→ lack of O₂ binding → not as much aerobic resp.

E. CO₂ transport - CH₂O + O₂ → CO₂ + H₂O + E

21. Name the chemical that picks up CO₂. (1)

hemoglobin

22. What is this chemical called after it binds to carbon dioxide? A small amount of CO₂ is carried by the blood in this form. (1)

carboxyhemoglobin

23. Most CO₂ is carried in the blood as a bicarbonate ion (HCO₃⁻).

a) Write the equation showing CO₂ being transformed into HCO₃⁻. (1)



- b) What is the enzyme used to accelerate this reaction? (1)

carbonic anhydrase ← in the RBC

- c) In the equation in a), there are H⁺ ions which may affect the pH of the blood.

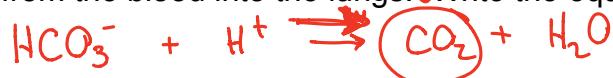
What happens to these H⁺ ions to keep a constant blood pH? (1)



- d) Once HCO₃⁻ has been made in the RBCs, where does it diffuse to? (1)

plasma

- e) Once the blood reaches the lungs, the chemical reaction reverses and CO₂ diffuses from the blood into the lungs. Write the equation for this reaction. (1)



F. Nutrients and Waste Transport

24. Which blood vessels carry nutrients to and remove wastes from cells? (1)

capillaries

25. Besides O₂, list 2 nutrients that are carried to cells. (1)

glucose, amino acids, fats, nucleotides, water, ...

26. The pumping of the heart produces *blood pressure* which forces nutrients and O₂ to leave the blood vessels by *filtration*. What type of substances, however, cannot leave the blood vessels? (1)

cells, platelets, plasma proteins

27. When materials leave blood vessels, they make up *tissue fluid*. What materials are found in tissue fluid? What materials are *not* found in tissue fluid? (2)

(interstitial fluid) plasma, HCO₃⁻, antibodies, nutrients, ...

28. List 2 waste products produced by cells that diffuse into the blood. (1)

nitrogenous wastes, CO₂, water.

G. Blood Clotting

29. When injury to cells occur, clotting or coagulation occurs to prevent excessive blood loss. List 3 blood elements needed for clotting and indicate where each is made. (3)

i. prothrombin → LIVER

ii. fibrinogen → LIVER

iii. platelets → bone marrow

ADEK

30. What coenzyme is necessary for the manufacture of one clotting element? (1)

vitamin K

31. What cells are *platelets* (thrombocytes) made from? (1)

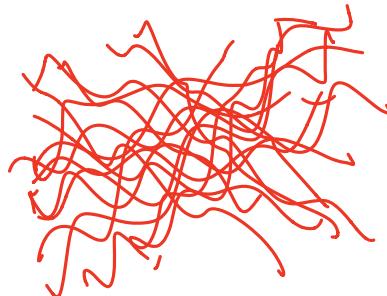
megakaryocytes

32. Draw a platelet. (1)



33. Look at my diagram of the clotting process. Write the series of chemical reactions that make up the clotting process. (3)

- i. damaged cells + platelets \rightarrow thromboplastin
- ii. prothrombin $\xrightarrow{\text{thromboplastin} + \text{Ca}^{2+}}$ thrombin
- iii. fibrinogen $\xrightarrow{\text{thrombin}}$ fibrin



34. What ion is needed for coagulation? (1)

Ca^{2+}

35. How can clotting be accelerated? (1)

pressure! elevate! relax!

36. What is serum? (1)

yellowish fluid oozes after clotting.

H. Infection fighting

Skin (when intact) prevents the entry of bacteria, viruses and fungi. If parasites do get past the skin, blood fights the infection with

- a) white blood cells (leucocytes)
- b) gamma globulins (antibodies)

37. Draw any leucocyte. (1)



38. List 2 major ways a RBC differs in appearance from a WBC. (2)

- i. *WBC have a nucleus.*
- ii. *WBC are bigger*



39. How many WBCs are found in a mm³ of blood? Leucocytes only live for a few hours to a few days. (1)

5 k - 10 k

40. There are 2 groups of leucocytes. List 2 ways *granulocytes* differ from *agranulocytes*. (2)

~~41. Draw a picture of each of the 3 granulocytes and name them. (3)~~

~~42. Where are granulocytes produced? (1)~~

~~43. Draw a picture of each of the 2 agranulocytes and name them. (2)~~

~~44. Where are agranulocytes produced? (1)~~

45. On the prepared blood smear slides, identify as many types of WBCs as you can. Get your drawings above initialed for extra marks.

46. Infections are fought mainly by 2 leucocytes. Name them and state how they fight invading organisms. (2)

- i. *phagocytosis → macrophage
neutrophil*
- ii. *antibodies / lysis → lymphocytes*

I. Inflammation

47. Infecting agents (bacteria, viruses, fungi) can destroy your cells in 2 ways. (2)

- i. directly → lysis
- ii. toxins

48. In response to an infection your damaged cells and (basophils) (WBC) release histamines. What two things do histamines do to your blood vessels? (2)

- dilate
- ↑ permeability

Because fluids now leave the blood vessels, swelling occurs and the region has *inflammation*.

49. Name 2 leucocytes that can now squeeze through the capillary walls and phagocytize the foreign invaders. (2)

- macrophages, neutrophils

50. Pus is a thick yellow fluid resulting from the battle between your WBCs and the foreign invaders. List 5 things found in pus. (3)

dead WBC, dead pathogen, dead cells,
live WBC, live pathogens

51. a) Name the very large (5-10x) phagocytic cell that devours 100s of invaders. (1)

macrophage

b) What was this cell called before it enlarged? (1)

monocytes

J. Antibodies

52. What type of WBCs produce antibodies? (Remember, each one produces only one type of antibody) (1)

lymphocytes

53. Antigens are *any foreign substance coming into your body* (viruses, bacteria, fungi, transplants, blood transfusions). Name 2 chemicals found in all antigens. (1)

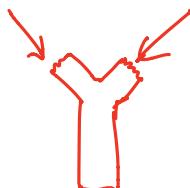
proteins carbs

carbs

proteins

54. Antibodies find and then neutralize antigens via a *lock and key* mechanism. What other proteins function in this way? (1)

enzymes



K. Lymphatic System

Besides arteries, capillaries and veins, there is another set of circulatory vessels called *lymph vessels*. When material is *filtrated* out of capillaries, *tissue fluid* is formed around the cells. If this fluid was not reabsorbed, you would swell (*edema*). Lymph vessels absorb this fluid and empty it into the *subclavian veins*.

55. Name the two types of lymph vessels (2)

lymph capillaries, lymph veins

56. What is a structure found in both blood veins and lymph veins? (1)

valves

57. There are 2 main lymph ducts. Fill in the chart for each. (2)

Lymph Trunk	Drains from	Empties into
right lymphatic duct	right upper body	right subclavian vein
thoracic duct	rest of body	left subclavian vein

58. *Lacteals* are also part of the lymph system. (2)

a) Where are they found?

villi

b) What is transported into them?

lipids

59. Along the lymphatic system are groups of lymphoid tissue called nodes. These have lymphocytes that produce antibodies to fight infections. (1)

60. List two other jobs lymph nodes do to purify blood and fight infections. (2)

trap bacteria

trap cell debris

61. When you are ill your doctor feels the lymph nodes to see if they are swollen. List 4 organs that contain lymphoid tissue and help fight infections. (2)

tonsils, appendix, thymus gland, spleen

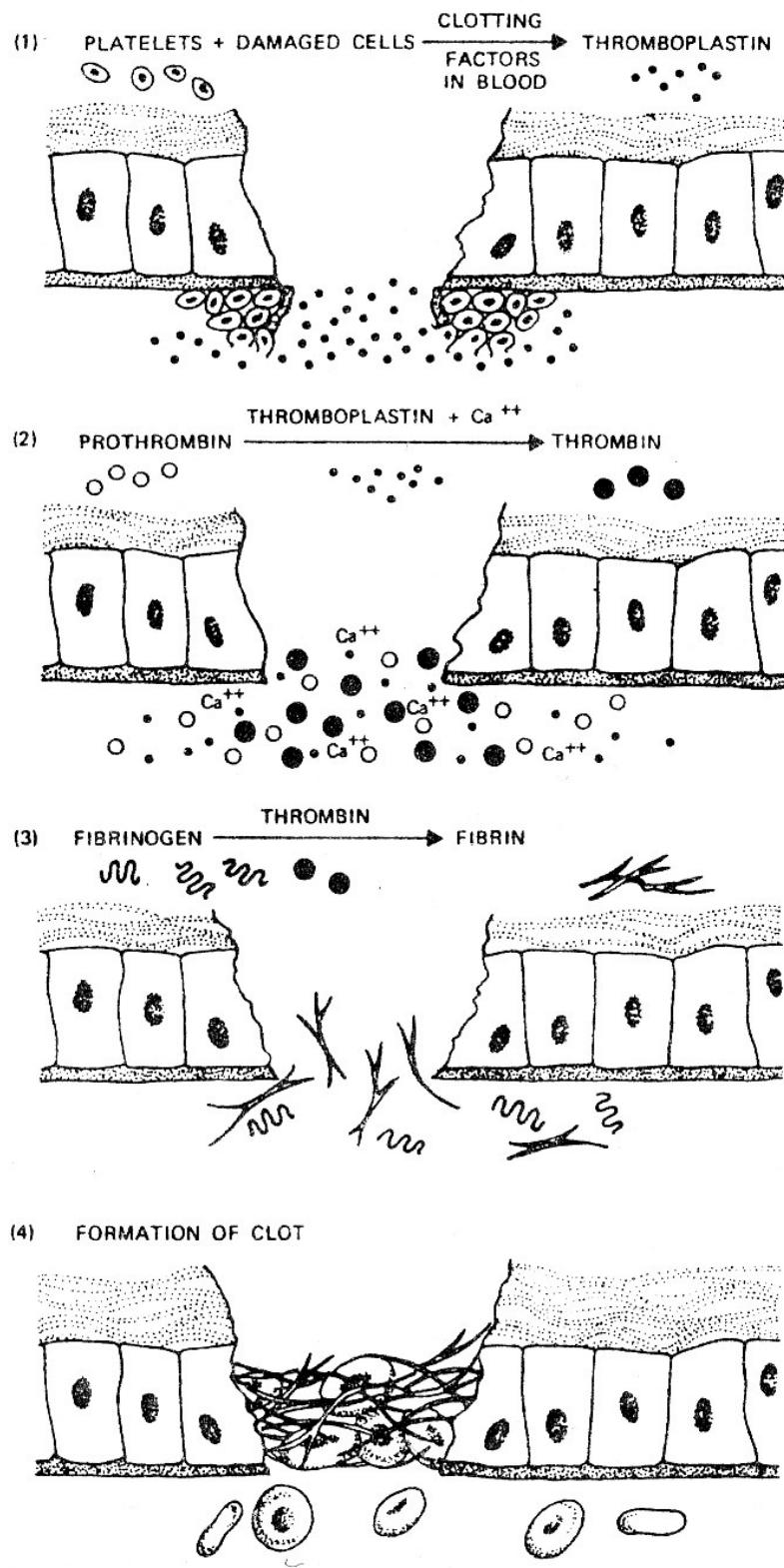
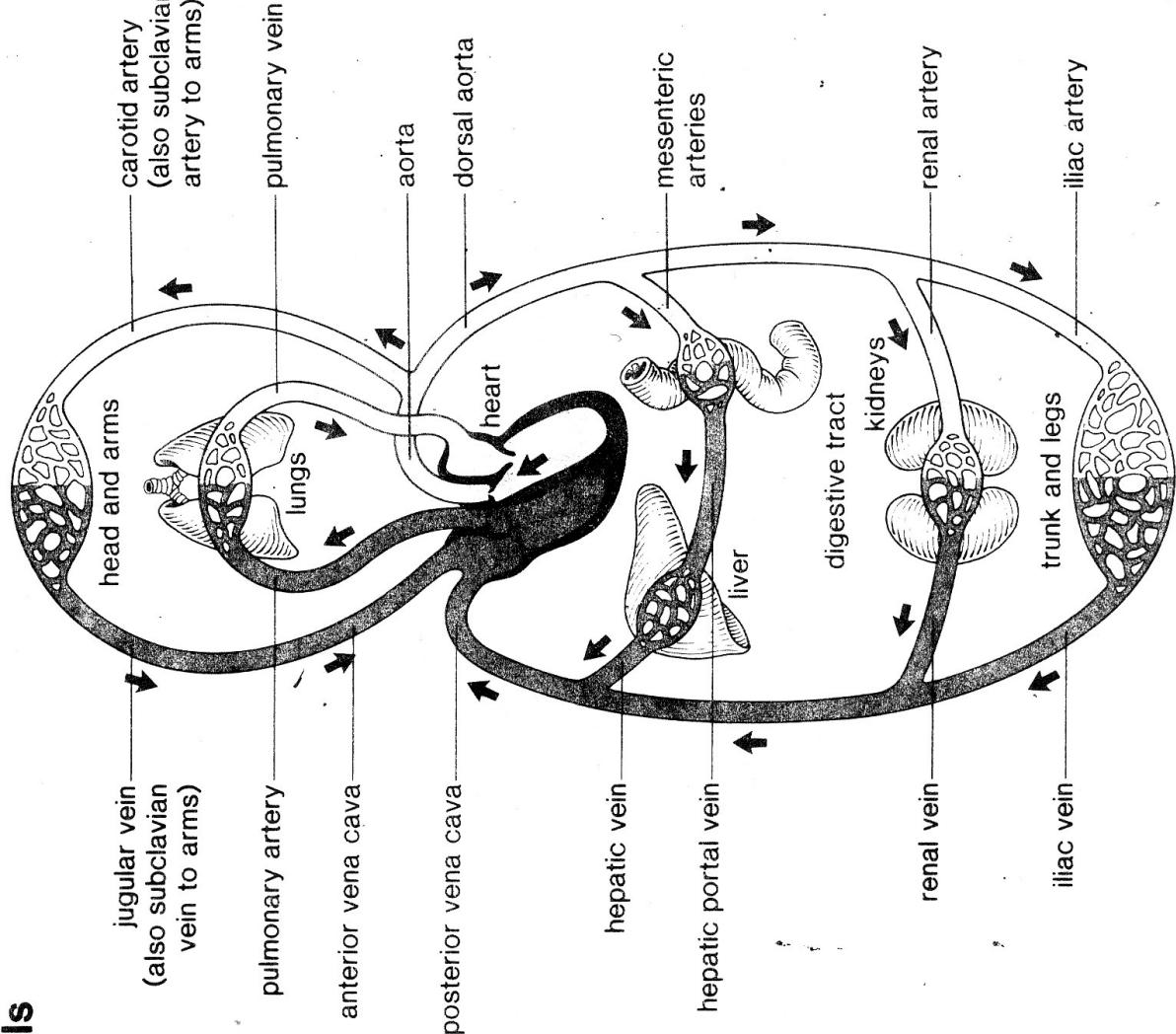


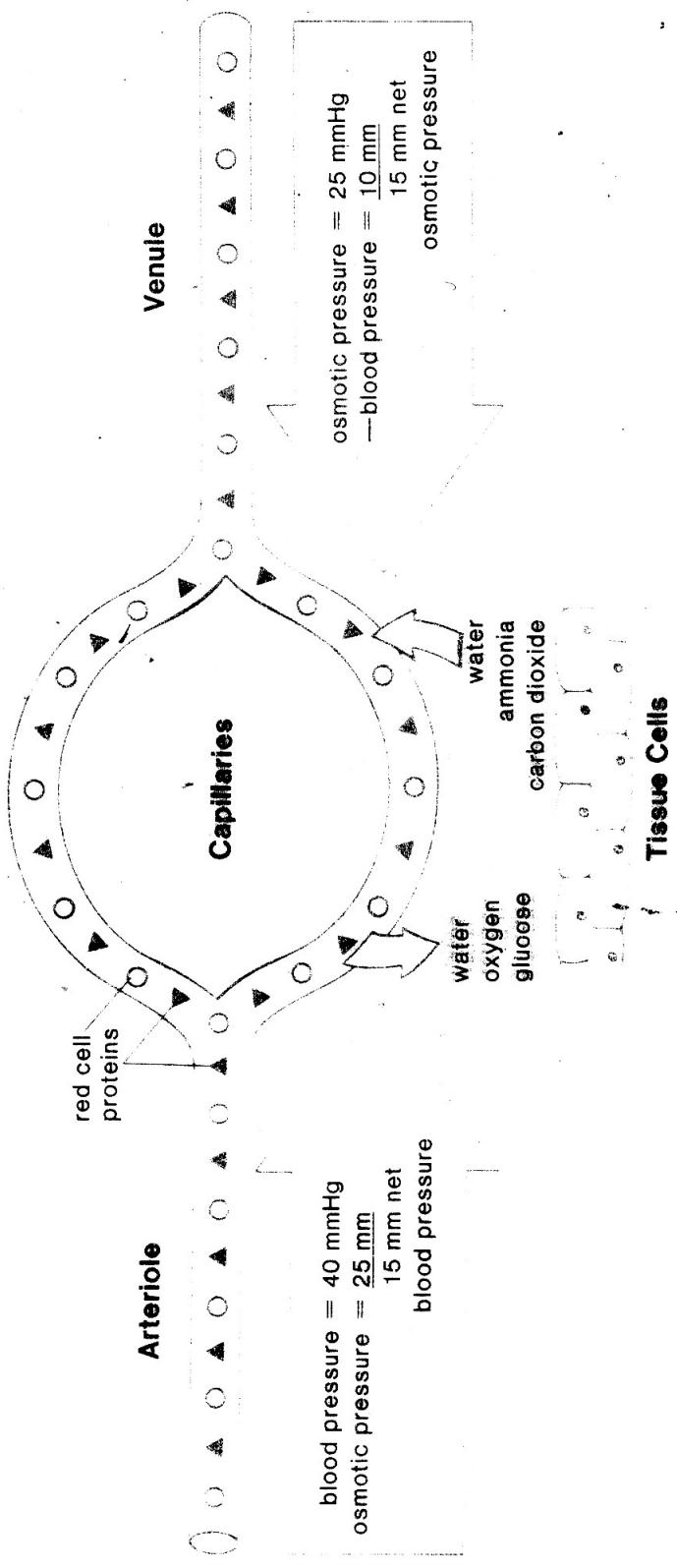
Figure 23.28 The mechanism of blood clotting.

19 Major Blood Vessels (Fig. 10.10)

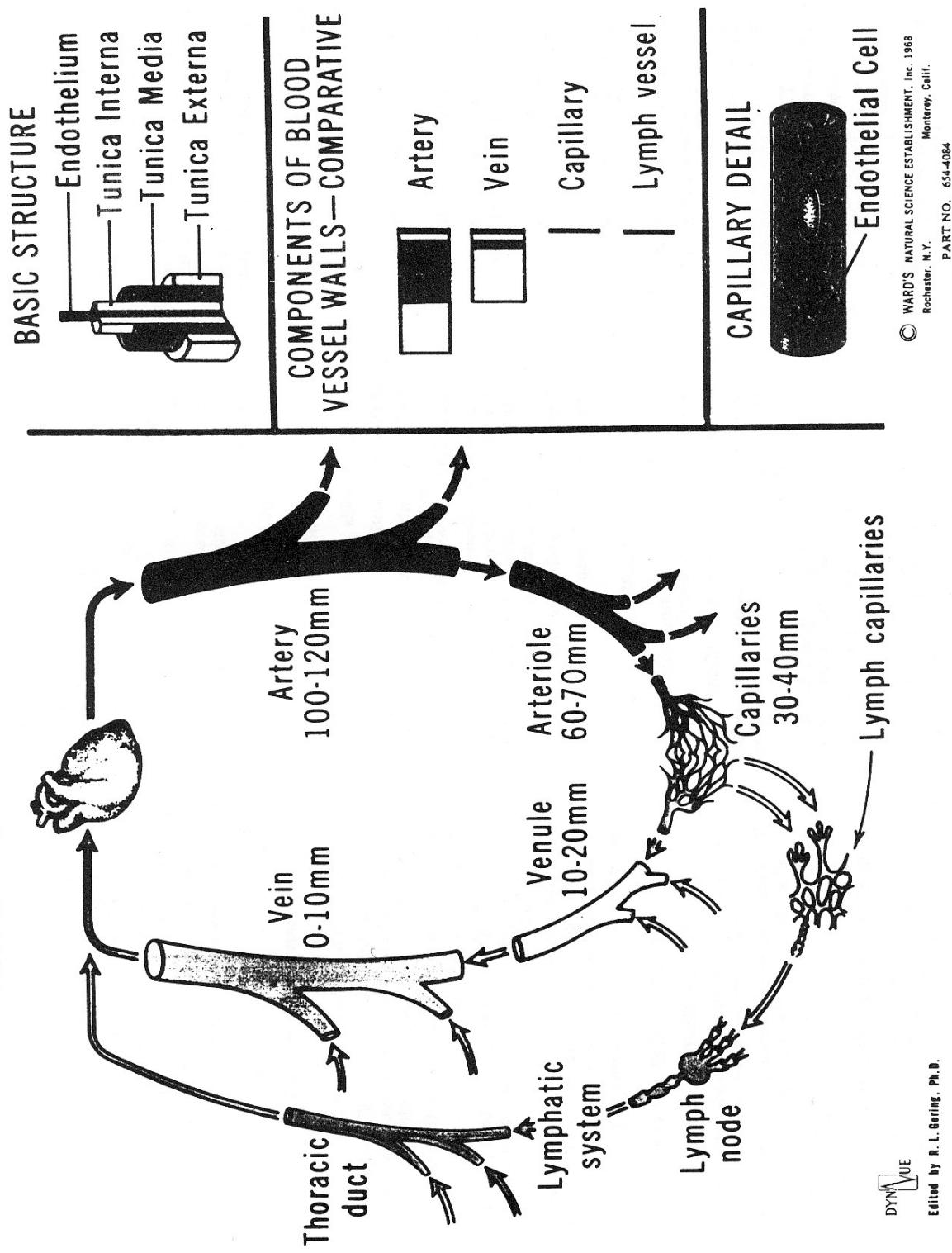


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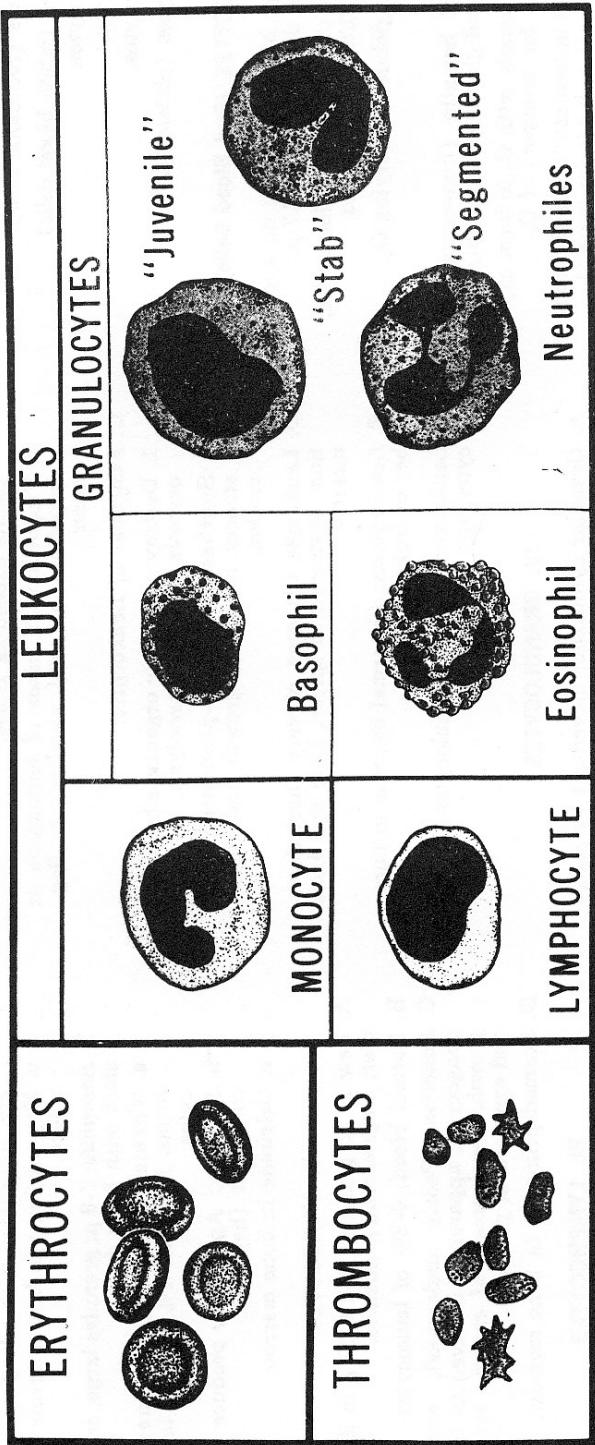
20 Capillary Exchanges (Fig. 11.8)



ARTERY-CAPILLARY-VEIN RELATIONSHIPS



BLOOD CELL TYPES

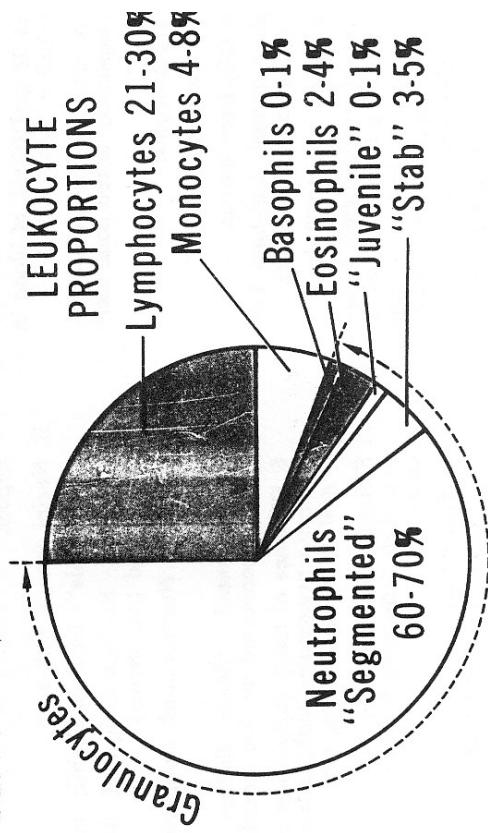


NORMAL NUMBER / mm³ of Blood

Erythrocytes: ♂ 5,000,000-6,000,000
♀ 4,500,000-5,500,000

Leukocytes: 3,500-10,000 (5,000)

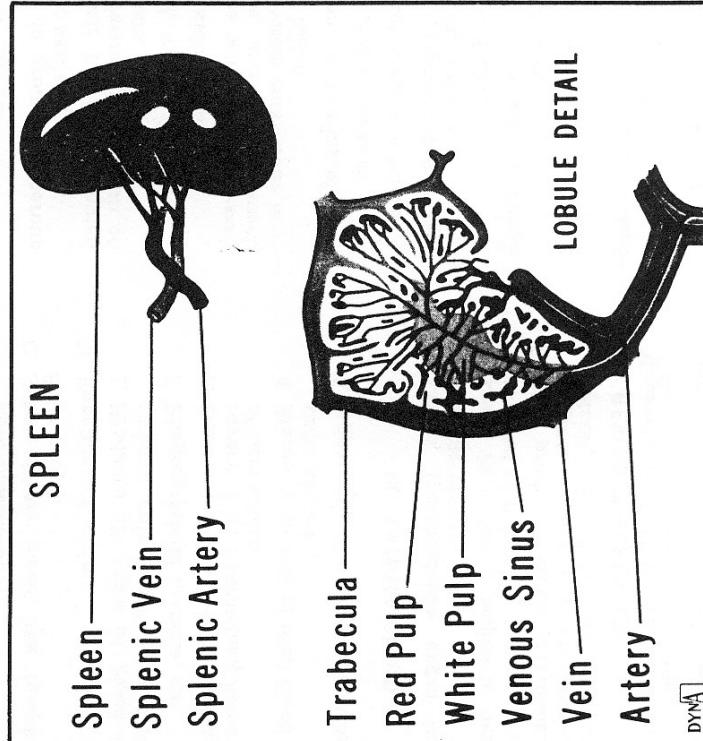
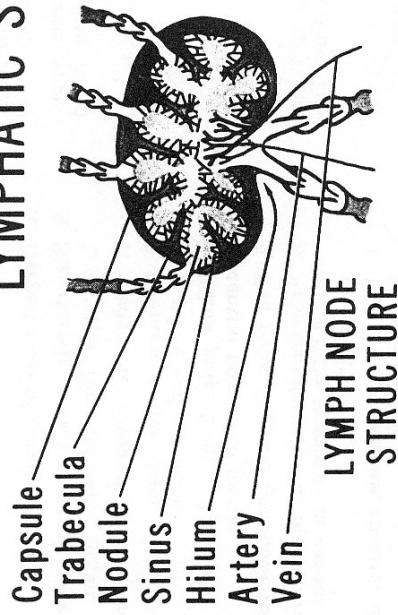
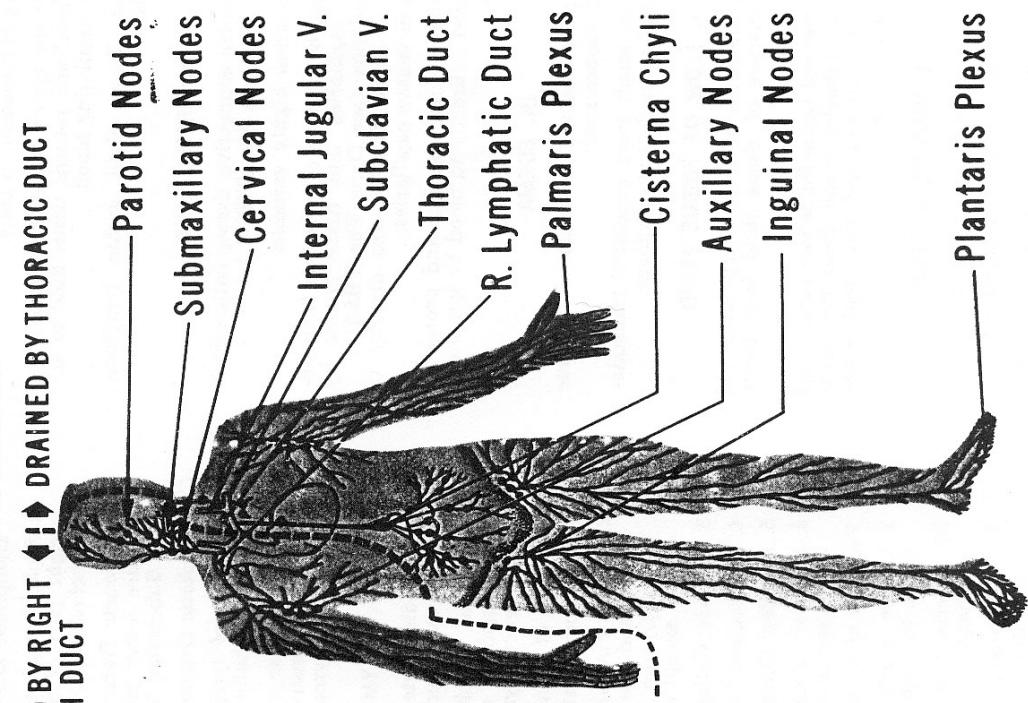
Thrombocytes: 200,000-600,000



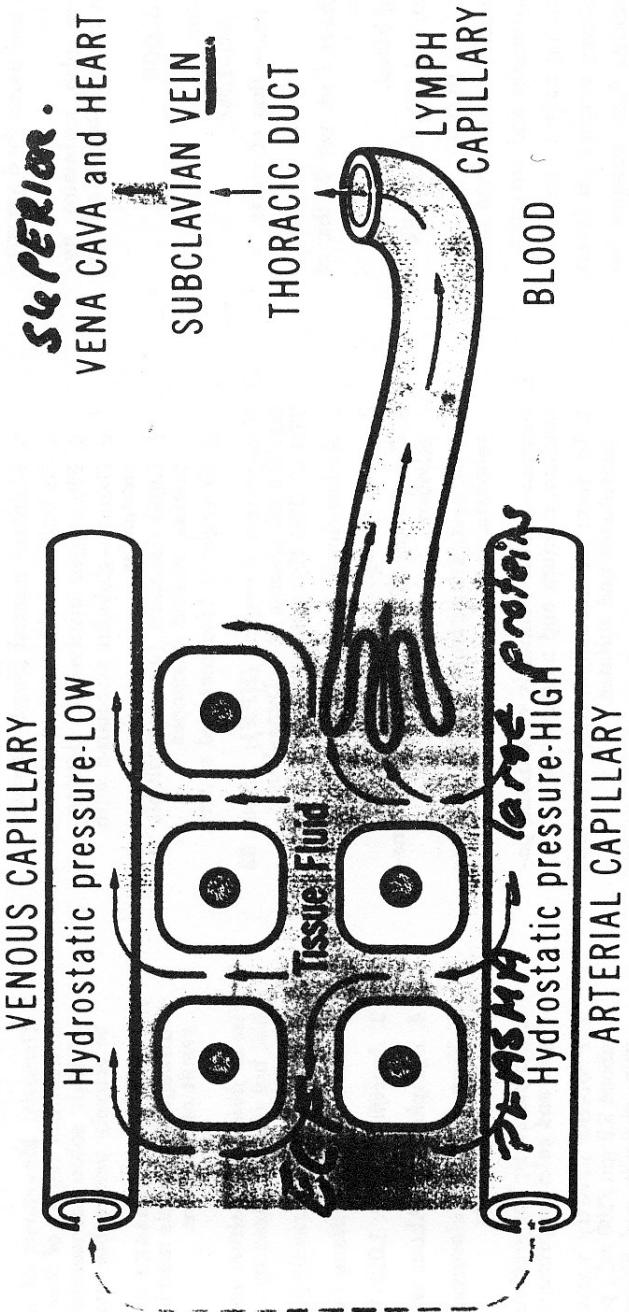
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LYMPHATIC SYSTEM—GENERALIZED



BLOOD VERSUS TISSUE FLUID (LYMPH)



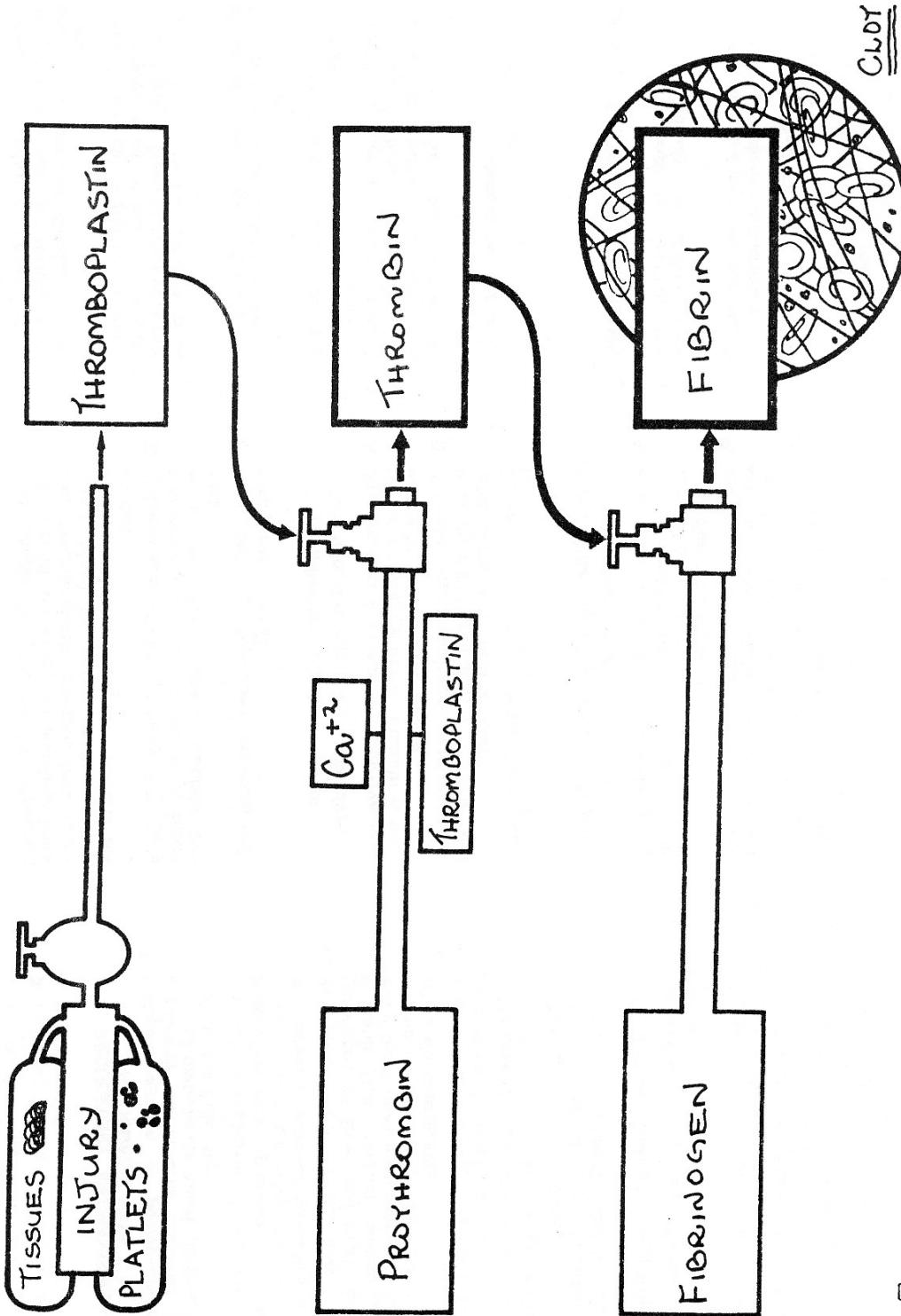
BLOOD	TISSUE FLUID (LYMPH)
1.041.1.067	1.015.1.023
c. 5,000,000/cu. mm. 63-77% of W.B.C.s. 21-30% of W.B.C.s. 4-8% of W.B.C.s. 200,000-600,000/cu. mm. 91.92% of plasma 7.0-7.5 gm./100 ml. 70-164 mg./100 ml. 500-800-mg./ml.	Normally none Normally very few Variable; about same as blood Normally none None 95% of tissue fluid Variable; maximum of 3.2 gm. Variable; some always present Very variable; about $\frac{1}{2}$ that of blood
Specific Gravity	
Red Blood Cells	
Granulocytes	
Lymphocytes	
Monocytes	
Thrombocytes	
Water	
Total Proteins	
Blood Sugar	
Blood Lipids	

DYNA

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BLOOD CLOTTING

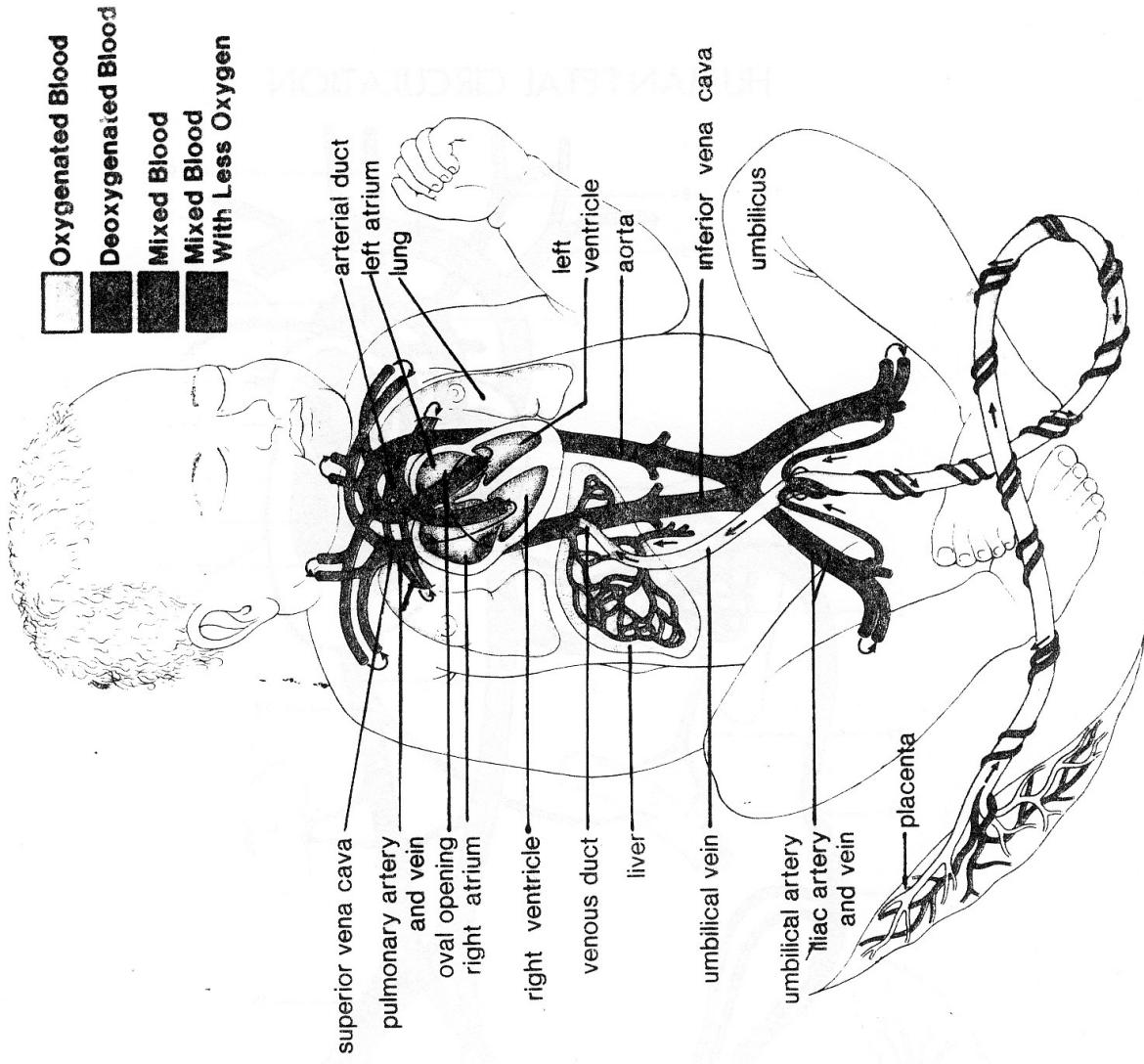


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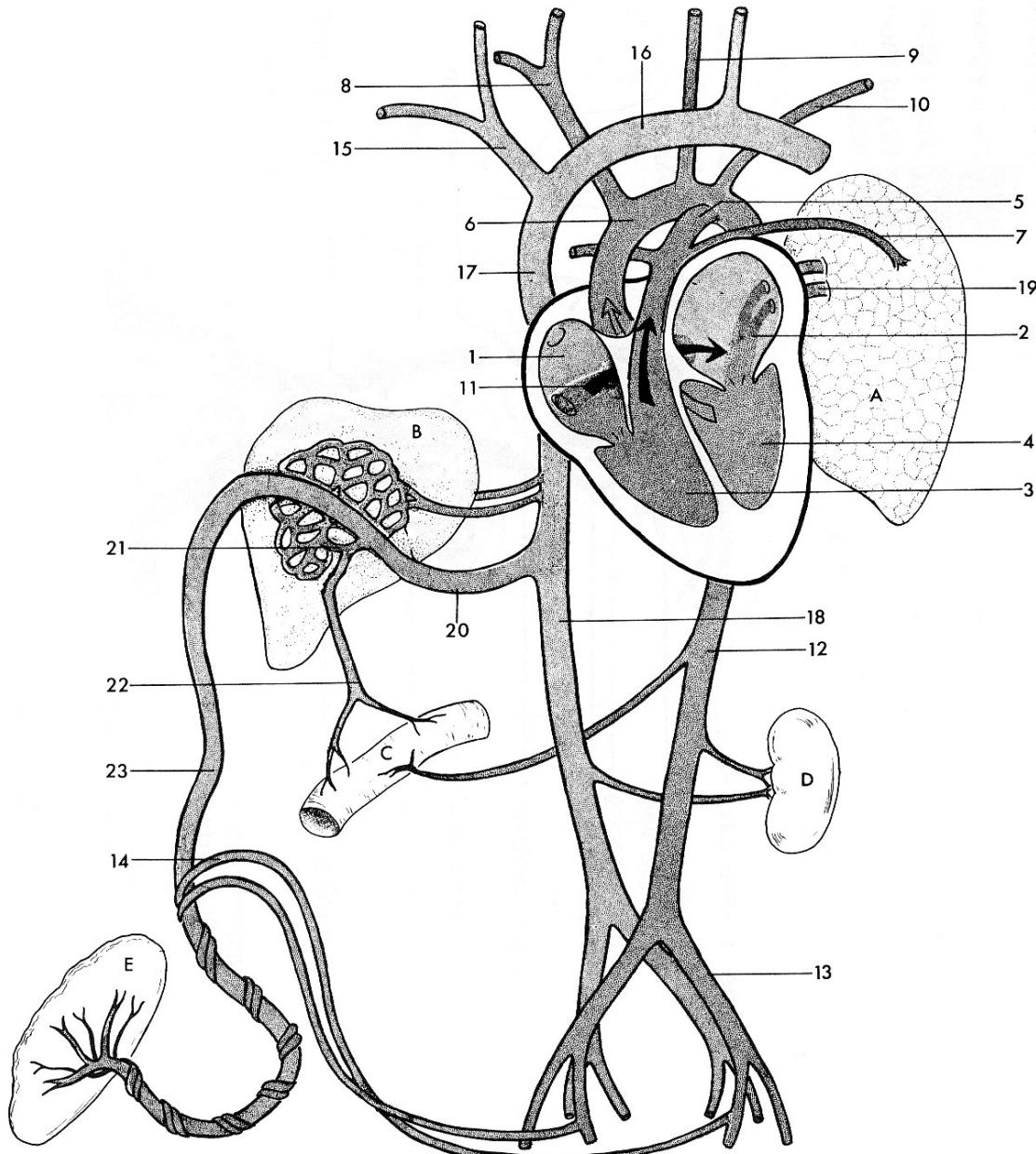
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37 Fetal Circulation (Fig. 20.17)



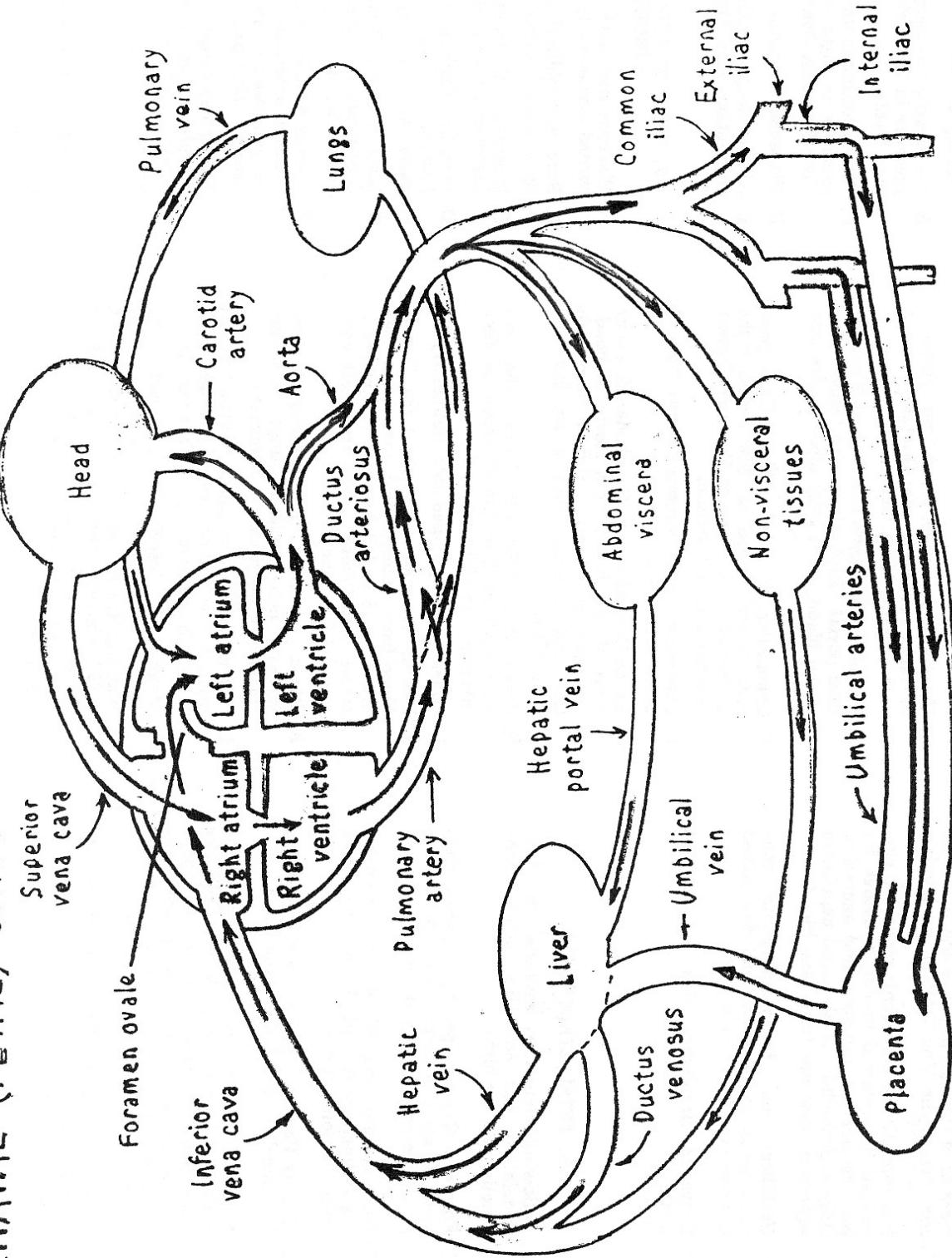
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HUMAN FETAL CIRCULATION



- 1. Right auricle
- 2. Left auricle
- 3. Right ventricle
- 4. Left ventricle
- 5. Ductus arteriosus
- 6. Systemic arch
- 7. Pulmonary artery
- 8. Innominate artery
- 9. Left common carotid
- 10. Left subclavian artery
- 11. Foramen ovale
- 12. Dorsal aorta
- 13. Common iliac artery
- 14. Umbilical artery
- 15. Right innominate vein
- 16. Left innominate vein
- 17. Precava
- 18. Postcava
- 19. Pulmonary vein
- 20. Ductus venosus
- 21. Hepatic vein
- 22. Hepatic portal vein
- 23. Umbilical vein
- A. Lung
- B. Liver
- C. Gut
- D. Kidney
- E. Placenta

PRENATAL (FETAL) CIRCULATION



POSTNATAL CIRCULATION

