HUMAN PHYSIOLOGICAL SYSTEMS: HOUR EXAM 2

1. (20pts) A patient with severe kidney disease as shown in the table is experiencing extreme protein loss from the plasma. The resulting Starling forces are given below.

	Kidney disease	Normal
Plasma Colloidal Osmotic Pressure, PCOP	25 mmHg	28 mmHg
Plasma Capillary Pressure, PCAP	17 mmHg	17 mmHg
Interstitial Osmotic Pressure, ICOP	5.4 mmHg	6.2 mmHg
Interstitial Fluid Pressure, IFP	-4.81 mmHg	- 5.00 mmHg

A. Calculate the Net Filtration Force in the capillaries for the normal and diseased state.

(PCAP - IFP) − (PCOP - ICOP)

diseased

(17+4.81) − (25 − 5.4)

21.81 − 19.6

2.21 mmHg

normal

(17+5) − (28−6.2)

22 − 21.8

.2 mmHg

1c/10

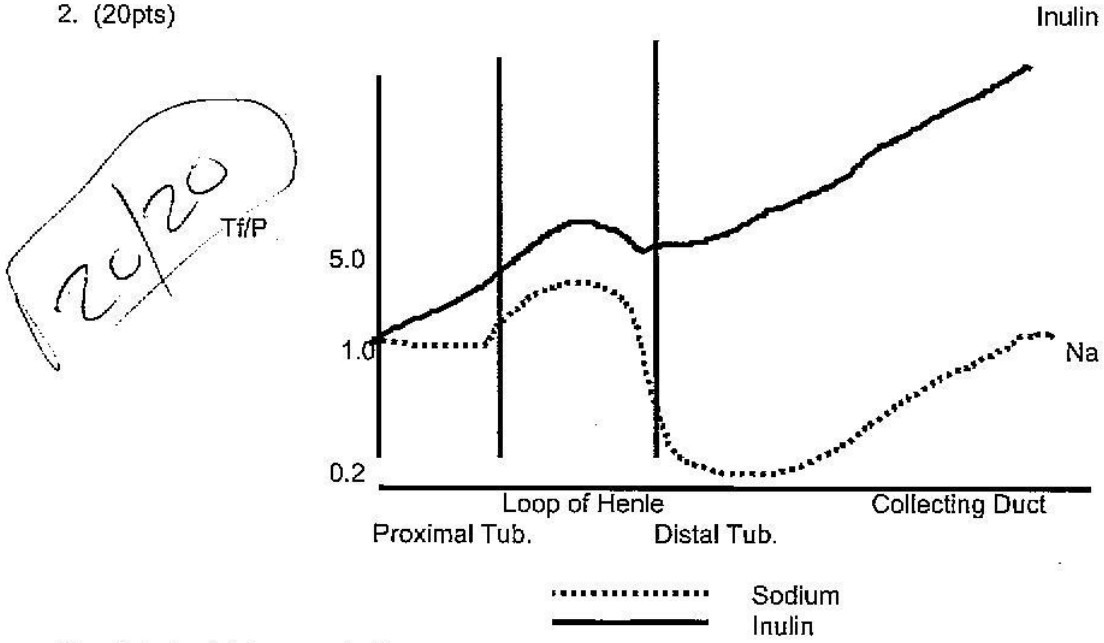
B. Explain why the forces changed in the diseased state.

Colloidal pressure is the part of total pressure contributed by the concentration of proteins & other substances. Because there are less proteins in the plasma, PCOP decreased. Since there was less plasma osmotic pressure, the interstitial osmotic pressure also decreased, IFP increased in order to try and counteract the decreased osmotic pressure.

1c/10

good

2. (20pts)



Tf = tubular fluid concentration
P = Plasma concentration

On the graph above are the inulin and sodium concentrations at different points along the nephron relative to the concentration of that substance in the plasma. A value of 1 indicates that the concentration is the same in the tubular urine as in the plasma. Explain the reasons for the changes in the concentrations. (Explain what happens to sodium and inulin as they move through the nephron)

Note: inulin is only filtered, not secreted or reabsorbed

Proximal tubule) H_2O and Na^+ are reabsorbed, causing Na^+ concentration to be constant and inulin concentration to rise

descending limb of loop of Henle) move to low ion permeability, high H_2O permeability. Na^+ and inulin are not being reabsorbed while H_2O is, so both concentrations rise

ascending limb of loop of Henle) H_2O impermeable, Na^+ highly permeable. Na^+ is being reabsorbed while H_2O is not so Na^+ concentration goes down, inulin concentration goes down as other ions are reabsorbed

Distal Tubule) Na^+ is [illegible] reabsorbed so concentration goes down, falling inulin concentration in urine and rising Na^+ concentration in plasma causes inulin concentration to rise and fall in each respectively

Collecting Duct) H_2O highly permeable. Falling H_2O concentration causes inulin and Na^+ concentration to rise

3. (15 pts) A physiology student, infused 1L of either plasma, saline, or water into a pig and measured the change in the body compartment volumes. The results, in the table below, are the volume increases caused by the infusion. The student forgot to label his experiments.

Solution	A	B	C
Interstitial Volume	501	169	761
Extracellular Volume	960	214	950
Plasma Volume	459	45	199
Cell H20 Volume	55	724	61

Using the data identify the solutions and explain how you identified the solutions.

A) Plasma infusion

Reason: Very high plasma volume, low cell H_2O volume, and high IV & EV.

B) Saline infusion

Reason: High water retention by cells caused by elevated salt levels

C) water infusion

Reason: Increase in fluid volume in all measured areas

10/15

4. (15 pts) A junior bioengineering major suffers a motorcycle accident on her way to class and loses 3/4 liter of blood (about 15% of total blood volume). Describe what happens to arterial pressure, and the initial, *short-term* reflex response(s) of the body to restore homeostasis.

Blood vessels constrict due to less +5
blood volume. This causes TPR to increase
which in turn increases arterial pressure.
The body wants to retain blood and slow/halt
its loss from the body. By constricting
blood vessels, less blood will flow to the wounded
area. The increased TPR causes Heart rate
to increase in order to normalize +2
CO. This causes an increase in
arterial pressure which dropped originally
due to the sudden loss in BV. +3

-5 baroreceptor reflex? Sympathetic/parasympathetic innervation?

-5

13/20

5. (20 pts) Over a period of minutes to hours, additional regulatory mechanisms controlled by the kidneys come into play for an attempted return to homeostasis. Describe specifically how the kidneys contribute to this process and their effects on arterial pressure.

Increased ADH (vasopressin) in the kidneys will increase water reabsorption to compensate for the fluid loss in blood. Also, renin production will increase which will increase RAS (Angiotensin I → Angiotension II → , etc.). This caused Aldosterone production to rise which increases salt and water retention. These processes will slowly increase arterial blood pressure over time

-4 what causes renin production?
-3 angiotensin II is a vasoconstrictor

0/10

6. (10 pts).When the bioengineering major finally gets to Samaritan, the ER physician wants to compensate for the lost blood. However, the student has a very rare blood type, so he decides to provide a transfusion of a different type. Should he transfuse a saline solution or a plasma solution? Justify your answer.

-5

Saline solution would be most effective because it would increase fluid retention in the body which would cause arterial pressure to rise towards a normal rate. Plasma transfusion would act similarly but would be created by the body more rapidly, making saline solution the better choice. -5

plasma should be used. Saline would ↓ blood osmolarity, leading to ↑ diffusion into the interstitial fluid

-17