URO-GENITAL SYSTEM

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Done By:

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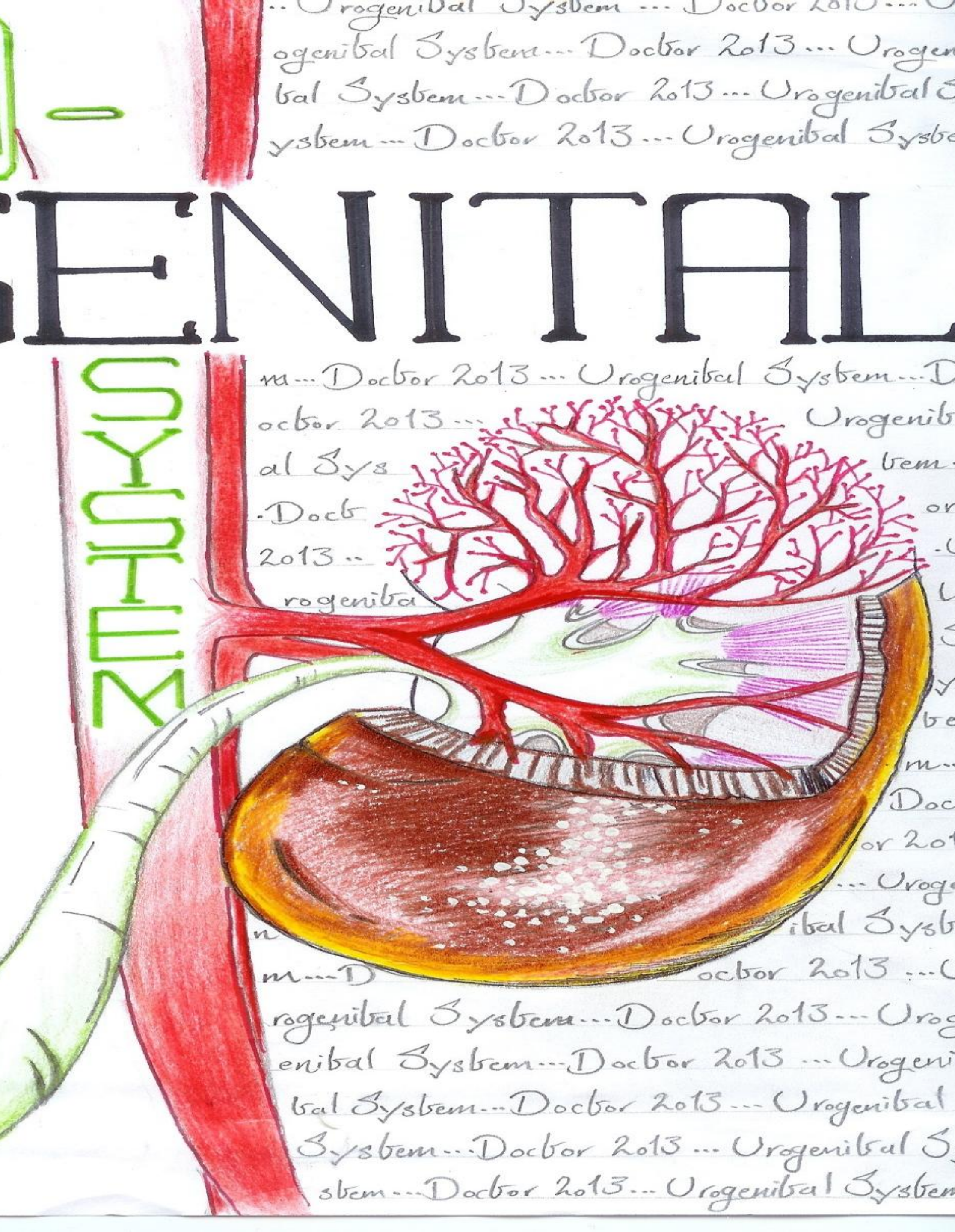
Lec. #: 2

Drawn By Tariq Bushnaq...



Review of the previous lecture:

-Kidney's function is to clean the blood by removing waste products.

-kidney failure will lead to death for many reasons, for example:

- Electrolyte imbalance
* K imbalance: lead to cardiac arrhythmias
• * Ca imbalance: affects bone (kidney is the major organ for Ca homeostasis)

- pH disturbance: acidosis, alkalosis.

- Kidney secret erythropoietin→ therefore, kidney failure leads to anemia

- Kidney regulates the volume of blood: kidney failure→hypertension, malignant hypertension→pulmonary edema

Today's **Lecture:**

- **Renal Blood Flow (RBF)**
- **Glomerular Filtration Rate (GFR)**

How to measure Renal Blood Flow?

Through this equation:

$$RBF = \frac{\text{Renal Plasma Flow}}{1\text{-Hct}}$$

So, if we assume that the RBF is 1250 ml and the Hct is 45%, the Renal Plasma Flow is ≈ **685 ml.**

The source of PAH in the urine:

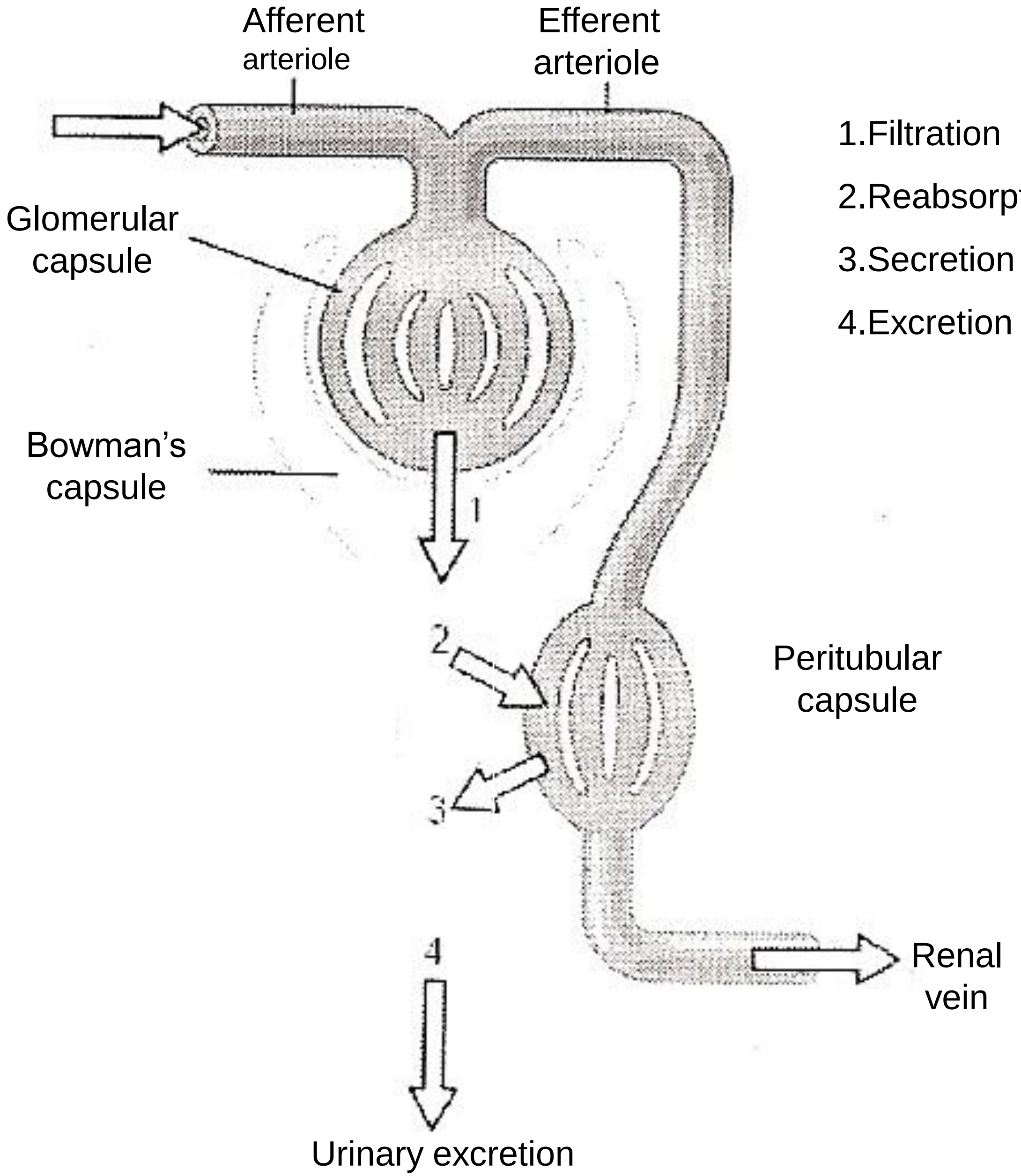
1. filtration 20%
2. secretion 80%
3. without any reabsorption.

1.Filtration

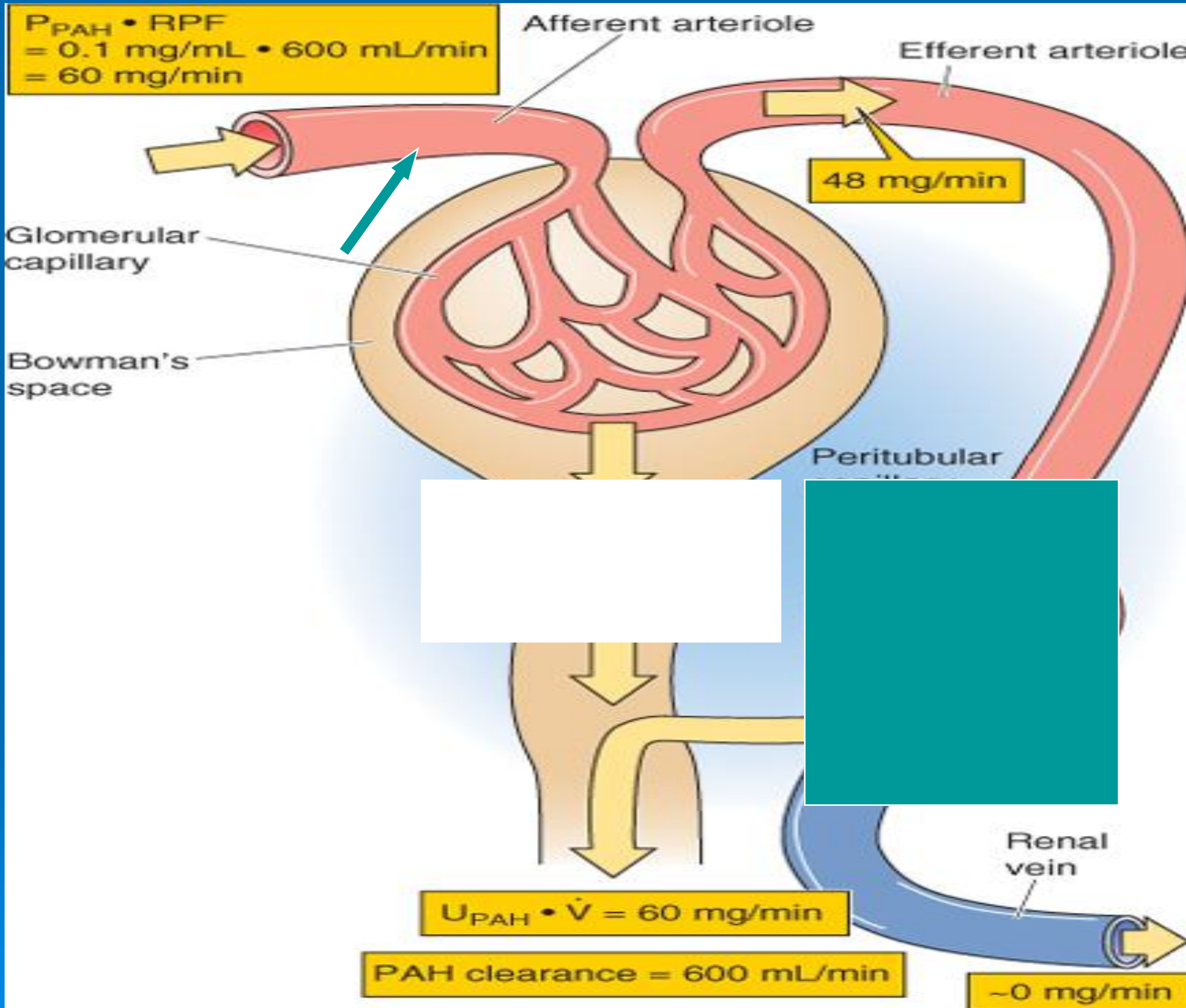
2.Reabsorption

3.Secretion

4.Excretion

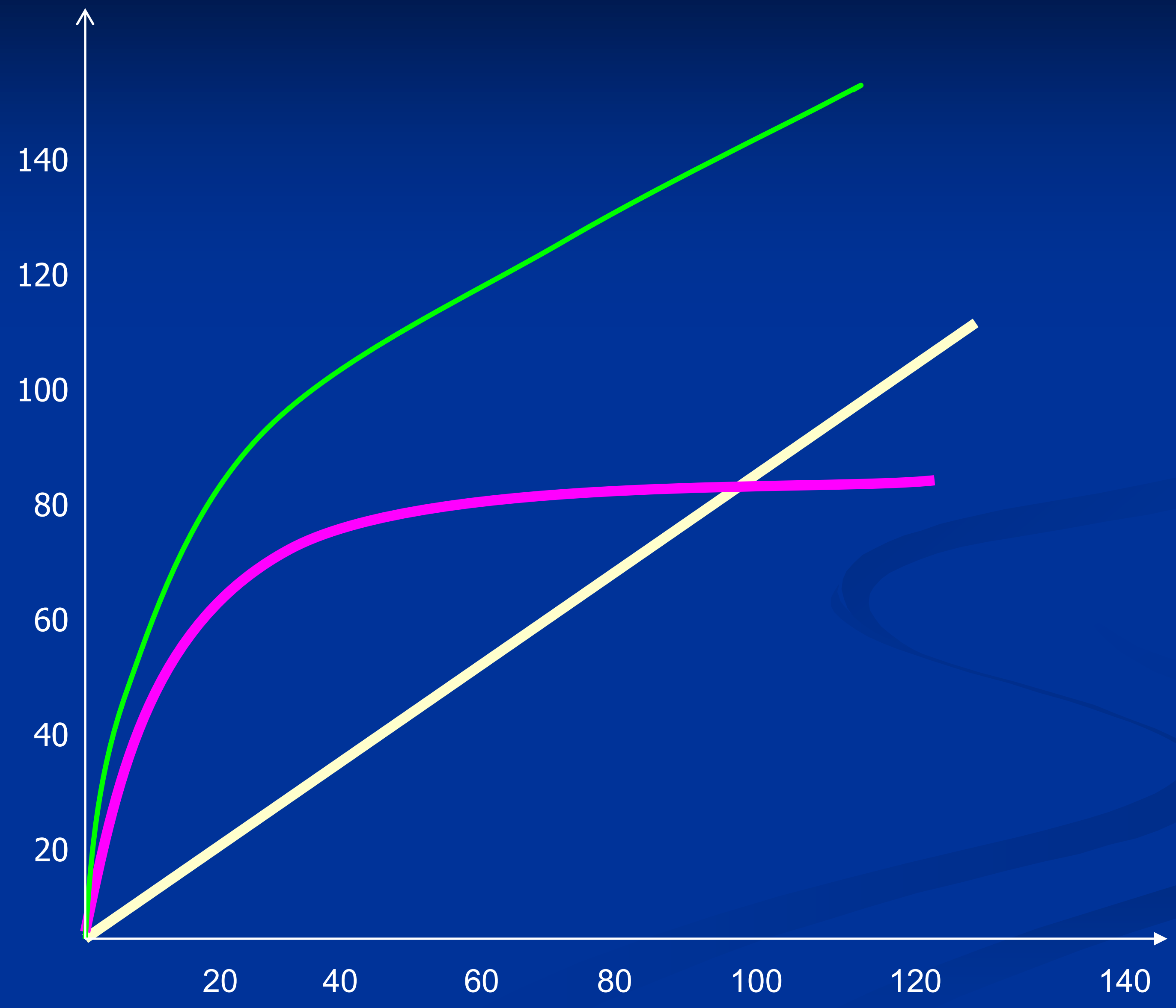


Excretion = Filtration – Reabsorption + Secretion



Boron & Boulpaep: Medical Physiology, 2nd Edition.

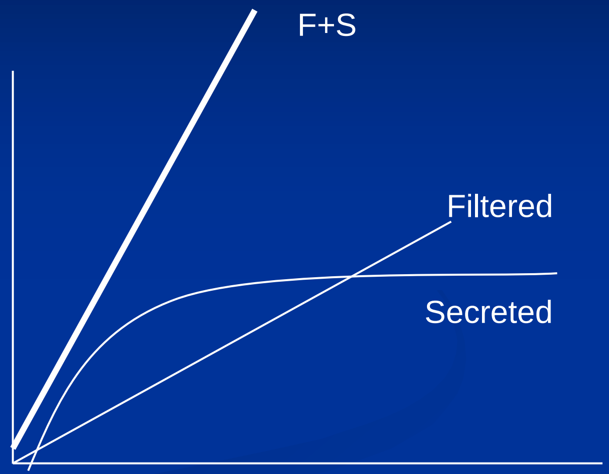
PAH CURVE for FILTRATION and SECRETION :



Remember:

PAH is completely cleared from plasma in the kidney…

under one condition…name it



- When we increase the PAH in the plasma, the filtration will increase proportionally (because filtration is a passive process).
(remember: 20% of the PAH is filtered)

- But in the case of secretion (which is an active process) after reaching Tmax…. No more increase in secretion…plateau phase

- So at a certain concentration the kidney will not be able to clear the whole plasma from that substance.

- If PAH delivered to the peritubular capillaries exceeds Tmax (<u>80 mg/min</u>) →→ PAH clearance becomes less than RPF (underestimation of RPF)

Let us look at it from different angle:
We will use "Law of Conservation of Mass":
Amount excreted in the urine/min = Amount provided for excretion (by artery)/min
- A x: is the amount of X entering the kidneys through the renal artery
- "X" leaves the kidney through: 1. renal vein or 2. through urine Thus: Ax = Vx + Ux

- *Conditions must be met before using "x" as RPF marker: X Is not accumulated in the kidney.*
- *Is not catabolized by the kidney.*
- *Is not produce by the kidney itself.*

If we assume that Vx equals zero, then:

Ux = Ax

Amount Excreted of X (mg/min) = Urine output (V) * U_x

Amount provided for excretion (mg/min) = RPF * P_x P=plasma

So…

RPF = (U_x/P_x) * V

PAH：

Paramino hippuric acid

A substance used to measure RBF (RBF marker),

how?

Through the equation, the amount of the substance that enters the kidney has to be excreted in the urine, so we need a substance that is totally excreted by filtration and secretion without any reabsorption to the vein and these criteria are found in PAH.

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Clearance:

-Cx: Is volume of plasma/min provide X for excretion.

-Unit of clearance: [Volume/time]

Examples:

- **We have 650 ml plasma with specific amount of X, after leaving the kidney all of the plasma was cleaned from X. 100% of 650 ml/min C_x= 650 ml/min**

- **We have 650 ml plasma with specific amount of Y, after leaving the kidney we find the same amount of Y. 0% of 650 ml plasma C_Y= 0 ml/min**

- **We have 650 ml plasma with specific amount of Z, after leaving the kidney we find half of the amount of Z. Clearance will be 50% of the 650 C_Z= 325 ml/min**

<u>GFR</u>

* When 125ml/min of plasma is filtered in Bowman's capsule, 1 ml of urine will be excreted and 124 ml will be reabsorbed (99.2%).

* How to measure GFR?

- We need a substance that is: freely filtered, not secreted and not reabsorbed.

- INULIN is an exogenous substance that meets these criteria

Filtrate Load of Inulin: the amount of Inulin filtered in Bowman space per min which is equal to the same amount *excreted in the urine/min*)

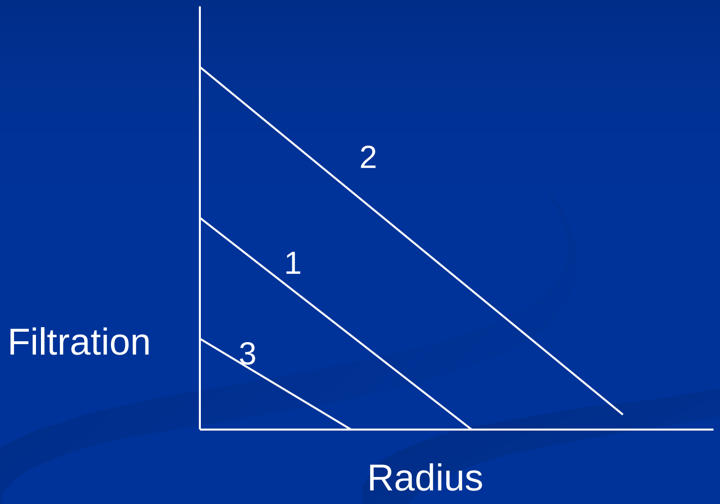
Inulin is a Glomerular marker. (<u>Inulin clearance = GFR</u>)

Excreted amount/min = amount provided for excretion/min

$$U_{inulin} * V = P_x * GFR$$

- Any substance with a MW less than 70 K can be filtered, and the filtration is inversely related with the radius:

(1) a neutral substance
(2) Is a cation substance: because it'll attach to the –ve basement membrane, more filtration.
(3) Anion: less filtration



Note:

Hemoglobin MW is less than 70 K. However, it is not filtered because Hb is bounded to protein: in hemolysis we can see Hb in the urine (pink urine).

- Since Inulin is an exogenous substance it is only used for research purposes and not as a clinical test.

We need an endogenous substance: **Creatinine**.

- ***Is muscle protein***
- ***Small molecule (MW is 114))***
- ***Its concentration does not fluctuate from day to day in plasma***

- ***Freely filtered, not reabsorbed but SLIGHTLY SECRETED***

To convert μmol /l of creatinine to mg/dl, divide by 88.4.

To convert mg/dl of creatinine to μmol/l, multiply by 88.4

Creatinine in the urine comes from 90% filtered and 10% through secretion. This has the potential to overestimates GFR by 10%. But in actuality it does not…why? In fact, it does overestimate GFR in end-stage renal failure…again WHY?

- Creatinine: Comes from high energy bound, muscle phosphocreatinine (PC)
- Plasma creatinine by itself (without creatinine clearance) is a good indicator of renal function because it does not relate to food intake or level of exercise.

Through this equation:

$$\text{Creatinin Clearance (GFR)} = \frac{U_{Cr}}{P_{Cr}} * V$$

Last point to describe which is the aswer to the previous question I asked you:
10% of <u>Cr in urine</u> is secreted which overestimates the GFR. But it was found that 10% of <u>Cr in plasma</u> is bounded to proteins (so, they canceled each others). We actually measure total plasma creatinine and not jus free creatinine in plasma.

Ccr is good estimation of GFR.