A *web*-HUMAN Renal Physiology Exercise

Renal Handling of Electrolytes

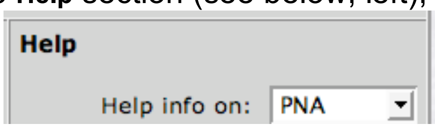
This exercise utilizes *web*-HUMAN as a simple lookup table to allow students to determine how the kidneys process two of the major blood electrolytes, sodium (Na+) and potassium (K+). The only values needed from HUMAN to achieve this are *concentrations* (e.g. urine [Na+]) and their associated *volume flows* (e.g. urine volume/min.) they are contained in. Once one has concentration and volume flow, the *mass flow* of each substance can be *calculated*. Thus, for urine Na mass flow:

Mass flow [mg/min.] = Volume flow [ml/min.] * Concentration [mg/ml]
(calculated) |<-- measured in HUMAN --->|

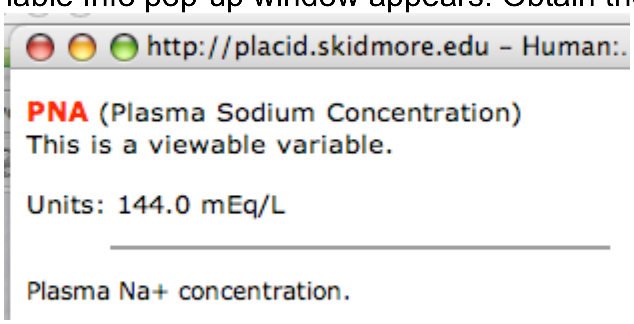
Always turn you pop-up blocker off before working in *web*-HUMAN.

I. <u>How to determine the 'names' and units of any variable</u> in *web*-HUMAN

- in the **Help** section (see below, left), mouse the variable of your choice.



- a Variable Info pop-up window appears. Obtain the name & units of the variable.

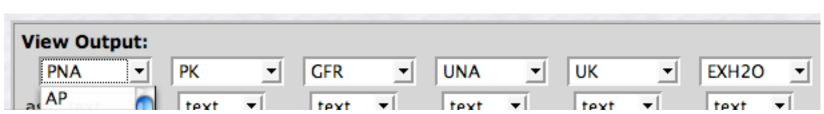


Using this method fill in <u>the units</u> in the accompanying table for PNA, PK, GFR and UNA, UK and EXH20. The actual current values will be determined by running the HUMAN model (see below).

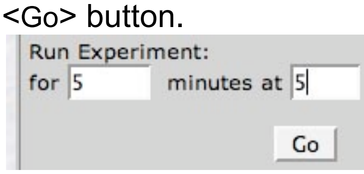
II. <u>Measuring the actual current values of variables</u> in HUMAN

To do this we run a quasi-experiment. The steps are outlined below.

A] We select the variables we wish to examine by placing them in the **View Output:** section. To obtain the values we need (e.g. plasma [Na+]) place them in the table as shown below.



B] We obtain their values in the model by running the model for 5 minutes. To do so, in the Run Experiment section, insert for <u>5</u> minutes at <u>5</u> minute intervals between data readouts and click the <Go> button.



C] An **Output from Web-HUMAN** table appears that contains the values at 0 and at 5 minutes. Work with the 5 minute value.

Using this method, fill in the concentrations and flow values in the accompanying table. Assume urine flow is equal to water excretion.

III. <u>Calculation of FILTERED and EXCRETED mass flows</u> (amount/time)
We now have concentration and volume flows for each chemical and can therefore calculate the mass flow for each. In the accompanying table, calculate** the mass flow FILTERED and EXCRETED for Na+ and for K+ (last column).
** Hint: Convert HUMAN concentrations from mEq./Liter (e.g. 100.1) to mEq/ml (e.g. 0.1001)

A. Determining the amount/time FILTERED into the tubular system from the blood
Using *web*-HUMAN*, determine and fill in the values for the following:

	Plasma Concentration**	[units]	GFR	[units]	Filtered	
NA	____________	_____	_____	_____	_______	meq./min.
K	____________	_____	_____	_____	_______	meq./min.

B. Determining the amount/time EXCRETED in the urine
Using web-HUMAN*, determine and fill in the values for the following:

	Urine Concentration**	[units]	Urine Flow[EXH20]	[units]	Excreted	
Na	____________	_____	_____	_____	_______	meq./min.
K	____________	_____	_____	_____	_______	meq./min.

IV. <u>Determining the amount/time REABSORBED by the tubules</u> from the nephron fluid. Since everything that entered the tubules (filtered) from the blood plasma must either show up in the urine (excreted) or have been reabsorbed back into the blood from the tubules i.e.

Filtered [mg/min.] = Excreted [mg/min.] + Reabsorbed [mg/min.]

we can now characterize the reabsorption of Na+ and K+ given the values we determined for Filtered and Excreted (see A. & B. immediately above)

	Filtered	[units]	Excreted	[units]	Reabsorbed*	
Na	____________	_____	_____	_____	___________	meq./min.
K	____________	_____	_____	_____	___________	meq./min.

* These calculations ignore the process of secretion. Instead they characterize the *overall* handling of these substances. Thus while K is, overall, reabsorbed, this could (does) result from a combination of secretory and reabsorptive steps.

V. Determining the amount/time REABSORBED PER HOUR & PER DAY

	Reabsorbed/min.	Reabsorbed/hr.	Reabsorbed/24 hr.
Na	____________	____________	____________
K	____________	____________	____________

Examine your data.

1) What percentage of the Na filtered per 1 minute is reabsorbed?

2) Consider the following:
- the total amount of sodium available in your blood is approximately 720 meq.
- assume that Na reabsorption is totally blocked.

At the end of 1 hour, what percentage of your blood sodium will be lost in your urine?

3) Briefly discuss why the failure of a specific reabsorption mechanism can rapidly prove fatal.