1. The time course of decay of plasma [inulin] can be simultaneously used to determine the ECF volume and the GFR. The disappearance of inulin is given by the first-order equation:

\[ \frac{dN_{\text{inulin}}}{dt} = -GFR \cdot P_{\text{inulin}} \]

Where \( N_{\text{inulin}} \) is the number of moles of inulin in the body and \( P_{\text{inulin}} \) is its plasma concentration. The plasma concentration is the total number of moles of inulin in the body divided by its volume of distribution, the ECF:

\[ P_{\text{inulin}} = \frac{N_{\text{inulin}}}{ECF} \]

Combining these two equations, we get

\[ \frac{dN_{\text{inulin}}}{dt} = -\frac{GFR}{ECF} N_{\text{inulin}} \]

This equation describes a first-order decay curve.

(A) Separate variables and integrate the first-order decay equation between the definite limits of time \( t = 0 \) and \( t \), corresponding to \( N_{\text{inulin}} = N_0 \) and \( N_t \).

(B) Two hours after establishing steady state in a 70-kg person and then stopping infusion, [inulin] falls from the steady-state value of 20mg/100mL to 7.2mg/100mL. Calculate GFR/ECF from the first-order decay equation.

(C) The total urine collected during 8h was 500mL, and the average inulin concentration was 560mg/100mL. Calculate ECF.

(D) From B and C, calculate the GFR.

2. The following test results were obtained over a 24h period:

- Urine volume = 1.2L
- Urine [inulin] = 110mg/100mL
- Urine [creatinine] = 170mg/100mL
- Plasma [inulin] = 0.8mg/100mL
- Plasma [creatinine] = 1.2mg/100mL
- Hematocrit = 0.40
Homework 4

(A) Calculate the clearance of inulin.
(B) Calculate the clearance of creatinine.
(C) What is the GFR?
(D) Creatinine is an endogenous by-product of muscle metabolism, originating from creatine. Assuming steady state, estimate the daily production of creatinine.
(E) If the filtration fraction is 0.18, estimate the effective renal plasma flow.

One model of the glomerular membrane is a microporous membrane in which right cylindrical pores penetrate all the way through the membrane. Assume that the pores have a length of 50nm and a radius of 3.5nm. The viscosity of the plasma is 0.002 Pa·s. The average hydrostatic pressure in the glomerulus is 60mmHg, hydrostatic pressure in Bowman’s space is 20mmHg, and the average oncotic pressure of glomerular capillary blood is 28mmHg.

(A) Calculate the flow through a single pore assuming laminar flow (use the Poiseuille flow equation).
(B) How many pores would there have to be to produce a normal GFR?
(C) If the total aggregate area of the kidneys for filtration is 1.5m², what is the density of the pores (the number of pores per unit area)?
(D) What fraction of the area is present as pores?