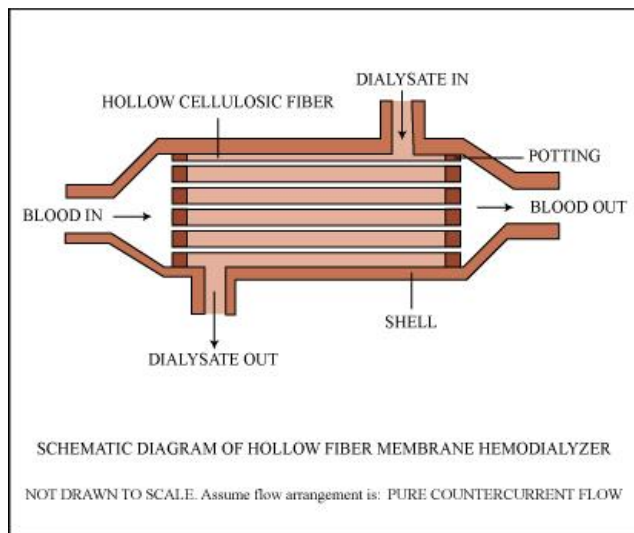Homework 3 (20 pts total)   DUE Wednesday 9/7 at the beginning of class

1. (5 pts) A cereal product containing 55% (by weight) water is made at the rate of 500 kg/hr. You need to dry the product so that it contains only 30% water.
    a) Draw a process flow diagram and label the mass flows and indicate the mass fractions of the components.
    b) Calculate how much water has to be evaporated per hour?

2. (5 pts) Strawberries contain about 15 wt% solids and 85 wt% water. To make strawberry jam, crushed strawberries and sugar are mixed in a 45:55 mass ratio, and the mixture is heated to evaporate water until the residue contains $1/3^{rd}$ water by mass.
    (a) Draw and label a flowchart of this process.
    (c) Calculate how many pounds of strawberries are needed to make 1 pound of jam.

3. (10 pts) An artificial kidney is a device that removes water and waste metabolites from blood. In one such device, the **hollow fiber hemodialyzer**, blood flows from an artery through the insides of a bundle of hollow cellulose acetate fibers, and *dialyzing fluid*, which consists of water and various dissolved salts, flows on the outside of the fibers. Water and waste metabolites – principally urea, creatinine, uric acid, and phosphate ions – pass through the fiber walls into the dialyzing fluid, and the purified blood is returned to a vein.

DIALYSATE IN

HOLLOW CELLULOSIC FIBER

POTTING

BLOOD IN

BLOOD OUT

SHELL

DIALYSATE OUT

SCHEMATIC DIAGRAM OF HOLLOW FIBER MEMBRANE HEMODIALYZER

NOT DRAWN TO SCALE. Assume flow arrangement is: PURE COUNTERCURRENT FLOW

At some time during a dialysis, the arterial and venous blood conditions are as follows:

	Arterial (entering) Blood	Venous (exiting) Blood
Flow Rate	200.0 mL/min	195.0 mL/min
Urea (H2NCONH2) Concentration	1.90 mg/mL	1.75 mg/mL

(a) Calculate the rates at which urea and water are being removed from the blood.
(b) If the dialyzing fluid enters at a rate of 1500 mL/min and the exiting solution leaves at approximately the same rate (1500 mL/min), calculate the concentration of urea in the exiting solution.
(c) Suppose we want to reduce the patient's urea level from an initial value of 2.7 mg/mL to a final value of 1.1 mg/mL. If the total blood volume is 5.0 liters and the average rate of urea removal is that calculated in part (a), how long must the patient be dialyzed? (Neglect the loss in blood volume, as this is being replenished by an IV in the patient's other arm.)