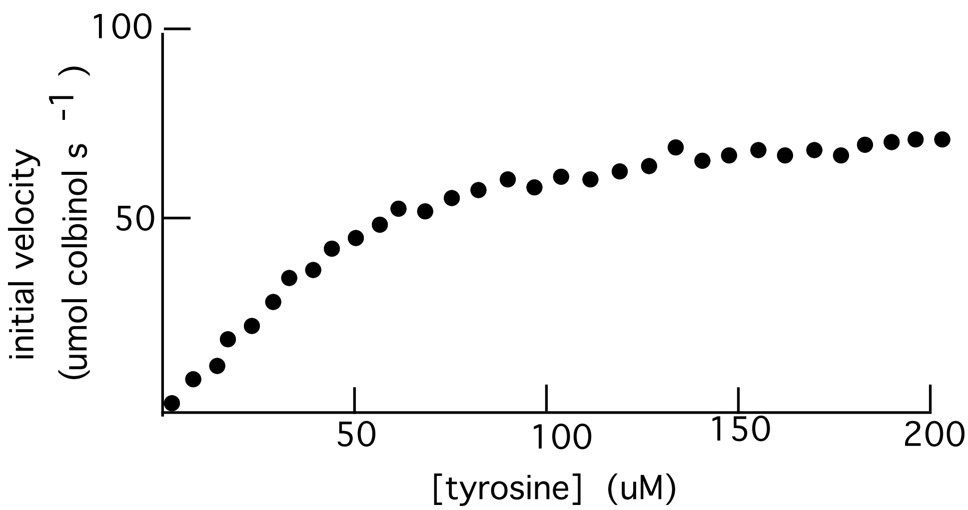
PLANT PHYSIOLOGY PROBLEMS #2

These problems should help you to become more familiar with doing calculations relating to enzyme kinetics and membrane transport. These are the same types of problems that just might happen to appear on exams.

1. In the process of screening plants from the Colby arboretum you have discovered that one of these plants produces a previously unknown compound that seems to have some anticancer activity. This compound, which you have named colbinol, is produced by the following reaction.

tyrosine $\rightarrow$ colbinol

You now wish to further investigate the enzyme (colbinol synthase) that catalyzes this reaction. To do this you have carried out a series of reactions. Each reaction mixture contained 0.3 μmol of purified colbinol synthase and varying amounts of tyrosine. The results of these reactions are shown below.



What is the V_{max} under these conditions?

75 μmol s^{-1}

What is the K_m of colbinol synthase for tyrosine?

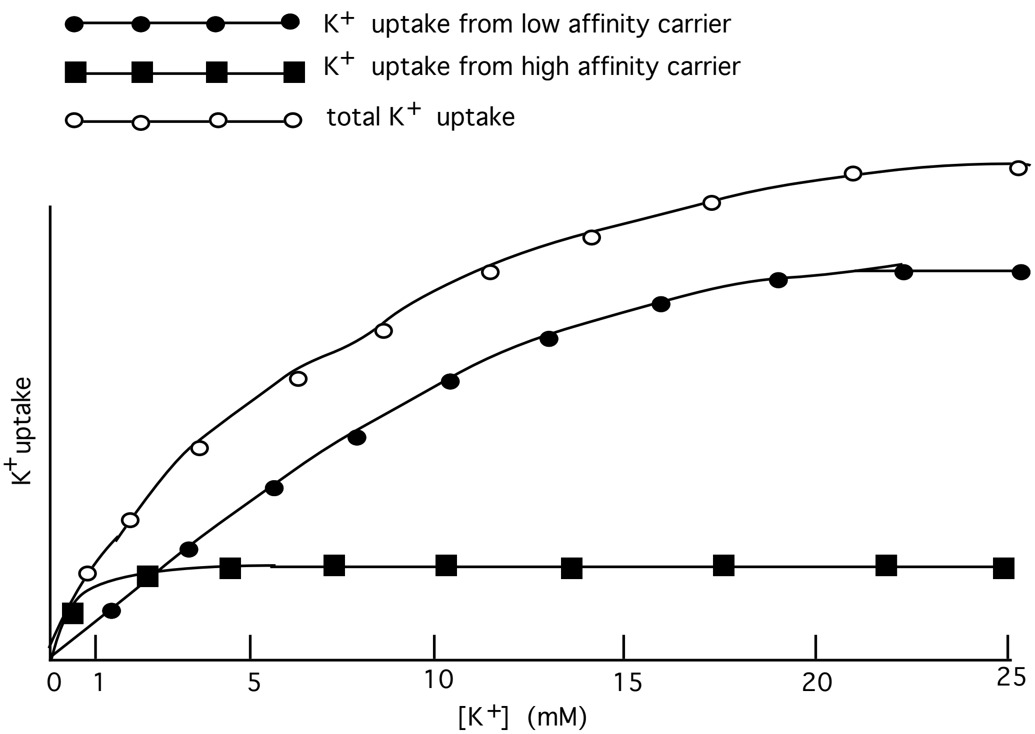
35 μM

What is the turnover number of colbinol synthase?

250 s^{-1}

2. Exploring in the Amazonian rain forest you have discovered a new species of plant, which in honor of your beloved college you have decided to name *Colbinus greenwoodii*. Your studies have shown that the root cortical cells of this plant have two different transporters that are responsible for the uptake of potassium ions. Both of the transporters display Michaelis-Menton kinetics. One of these is a low affinity transporter with a K_m for K^+ of 7 mM. The other is a high affinity transporter with a K_m for K^+ of 0.3 mM. The capacity of the low affinity transport system is 4 times as high as the capacity of the high affinity transport system.

Draw the following uptake curves on the graph below:



3. A plant physiologist used a microelectrode to measure the electrical potential difference across the plasma membrane of a root cortical cell and determined it to be -118 mV (negative inside the cell). The root was bathed in a nutrient solution containing 1 mM Ca^{2+} and this solution was allowed to reach equilibrium with the solution in the root apoplast.

a) if the calcium ions reach a state of electrochemical equilibrium between the inside and outside of the cortical cell, what concentration of calcium ions would you expect to find on the inside of the cell?

at equilibrium, $[Ca^{2+}]_{in}$ = 10M

b) measurement of the actual [Ca^{2+}] showed that it was 4 mM. What does this tell you about the way calcium is taken up into the plant?

$[Ca^{2+}]$ in the root cortex cells is clearly maintained at a level way below the equilibrium amount. Probably Ca^{2+} is being actively transported out of the cortex cells.

4. Amazing, you have also discovered that colbinol can be converted into colbinal, which is very toxic to insects. You have identified an enzyme (colbinol dehydrogenase) that catalyzes this conversion. You have determined that the turnover number for colbinol dehydrogenase is 480 s^{-1} and that its K_m for colbinol is 150 μM. If you were to carry out a colbinol dehydrogenase reaction in a test tube containing 1 mL of a suitable aqueous buffer, 500 μM colbinol, and 100 μM colbinol dehydrogenase, what initial reaction velocity would you expect to observe?

v = 37 μmol s^{-1}