centration which does not affect the position of the membrane. Such a solution is "isosmotic" or "isotonic".

Determine the molar concentration which is isotonic in the case of cane sugar, glucose, NaCl, $CaCl_2$ potassium chromate and dichromate.

By plasmolysis de Vries calculated the "isotonic coefficient" of salts, taking $KNO_3 = 3$ as the standard. Give the coefficient for the above substances.

Consider relation of osmotic pressure (tonicity) to molar concentration and ionization.

4. Turgidity. Place a slender strip of living tissue (carrot, turnip, etc.,) in each of a series of solutions which range from marked hypertonicity to marked hypotonicity, and note the results.

Note that "turgidity" may be used to denote rigidity of tissues arising from other causes. (See under 'swelling', Syn. IV,)

5. Changes in Permeability; Toxicity.

(a) Treat onion epidermis with strong alcohol followed by water. Does 1/N KNO_3 now induce plasmolysis? Repeat with iodine in water solution.

In this connection it is important to get a clear concept of the plasmatic membrane as having its permeability altered.

(b) To determine if toxic substances penetrate before they kill, or in weak non-toxic concentrations. Make a solution of sugar isotonic to the plant cells and then add a minute trace of strong alcohol or NH_4OH. Osmotic pressure is increased. Does plasmolysis take place?

6. Antagonism of Ions.

(a) Determine the molar concentrations of NaCl and of $CaCl_2$ isotonic with the cells of onion epidermis (i.e. the upper limits of hypotonicity). Using a mixture of these salts, is this mixture now equivalent in its physiological actions to that of either salt alone?

(Note. In the case of Spirogyra, Osterhout found that a mixture of 10 c.c. of .375 M NaCL (hypotonic) and 10 c.c. .195 M $CaCl_2$ (also hypotonic) was hypertonic. "Science n.s.34, 187, 1911). Increase in ionization is a factor to be taken into account.

(b) Thin slices of beet are washed in distilled water and are placed in equal quantities .1, .2, .3 and .4 N NaCl and in corresponding strengths of NaCl and $CaCl_2$ in ratio 9:1 for an interval of two hours. Note the amount of pigment which has escaped by colorimeter method (the environing solutions are poured into test tubes to same depth and colour compared). The slices are now placed in tap water with a small amount of $CaCl_2$ added, and are kept till following day.

Theoretical consideration.

The toxic effect of NaCl (Osterhout), antagonism of ions, physiological balance.

Refer to Syn. II, "Toxicity". How does lowering surface tension affect the concentration membrane on protoplasm? Result on permeability?

7. Osmotic Phenomena in Animal Cells.

(a) Haematocytes. Determine the isotonic solutions of NaCl, KNO_3 and $CaCl_2$, using crenation as an index of plasmolysis. (1/N solns. supplied).

Is the concentration identical for the three salts?

(b) **Squamous epithelium of frog's bladder.** Tease out frog's bladder so as to show the epithelium in profile. Irrigate with distilled water, and note the peculiar swelling of the membranes,apparently leaving the protoplasmic mass; followed by swelling of nucleus and cytoplasm; Brownian movement of particles in cytoplasm and in clear area.

Now irrigate with N KNO_3 Study the character of shrinkage, noticing buckling of membrane (if cytoplasm has not filled it out?) Observe also the behaviour of the erythrocytes, changes in shape, laking, etc.

(Note. It is not yet accurately known what the significance of all the above behaviours is. They deserve careful study.

(c) **Demonstration:** The gastrocnemius muscle of frog will be used to demonstrate the effects of sol'ns of different concentrations (salts).

8. Negative osmose. Test the relative efficiency of citric acid solution and pure H_2O in restoring the turgidity of plasmolysed cells.

9. Glandular action, Secretion, Excretion, Filtration.

(a) **Filtration.** Construct an artificial gland by hollowing out a piece of beet, or carrot, and introducing a strong solution of cane sugar. What is the dominating factor here?

Do sugar, salts, etc., escape however as well as water? A piece of tissue is washed and kept in distilled water in a vial, and the water later tested for sugar, NaCl. If red tissue is used, the colorimetric method may be used.

The factors concerned in glandular action are usually more complex than here illustrated. In addition to normal osmose (including evaporation), the osmotic pressure of colloids, negative osmose, manometric pressure and changes in permeability have also to be taken into account.