Factors affecting cell membrane permeability

Aim: to investigate the factors affecting cell membrane permeability of red cabbage, using absolute alcohol (10 cm3), 1 M hydrochloric acid (10 cm3), 1M sodium hydroxide (10 cm3), and distilled water (10 cm3), and change of temperature (40 oC, 65 oC, 100 oC)Hypotheses: If the leaf discs are not rinsed, the distilled water will change colour, because the pigments can escape from the cell destroyed by cutting the cabbage. If the temperature increases, the solution will become more and more coloured, because the membrane becomes more and more permeable. Independent variables: for tubes 1-2: rinsing or not rinsing the leaf discs; for tube 3-5: the environment;(for tubes 4-5: pH); for tubes 6-8: temperature. Dependent variable: for tubes 1-2: change of colour of the solution; for tubes 3-5: change of colour of the solution; for tubes 6-8: intensity of colour of the solution.

Controlled variables: for all tubes: species, size of leaf discs, amount of solution, for tubes 1-2: pH; for tubes 1-5: temperature; for tubes 6-8: pH. Materials: absolute alcohol, 1 M hydrochloric acid, 1 M sodium hydroxide, distilled water, red cabbageEquipments: test tubes, test tube rack, beaker, syringe or pipette, thermometer, Bunsen burner, gauze, tripod, implement for cutting the red cabbage into discs, waterproof marker pen, white paper, watchMethod: 1. Label test tubes 1-8. 2.

Into test tube 1 add 10 cm3 distilled water and three similar sized leaf discs freshly cut from the cabbage, then set the tube aside. 3. Place three rinsed discs into test tubes 2-5. 4. To test tube 2 add 10 cm3 distilled water.

5. To test tube 3 add 10 cm3 alcohol. 6. To test tube 4 add 10 cm3 hydrochloroc acid. 7. To test tube 5 add 10 cm3 sodium hydroxide and set tubes 2-5 aside.

8. Place three more rinsed discs into three test tubes (three each) with 10 cm3 disitlled water and place them into a 250 cm3 beaker (water bath). 9. Heat the water bath to 40 oC, maintain this temperature for two minutes, remove a test tube, label it 6. 10.

Continue to heat the water bath to 65 oC, maintain this temperature for two minutes, remove another test tube, label it 7. 11. Continue to heat the water bath to 100 oC, maintain this temperature for two minutes, remove the last test tube, label it 8. Data collection: Table 1.

Observations of testing the cell membrane permeability of red cabbage when the independent variable is rinsing or not rinsing the leaf discsTest tube number/ -State of leaf discs/ -Change of colour/ -1not rinsedtransparent, no change2rinsedtransparent, no changeNote: disitlled water is transparentDrawing 1. Observations of testing the cell membrane permeability of red cabbage when the independent variable is rinsing or not rinsing the leaf discsTable 2. Observations of testing the cell membrane permeability of red cabbage when the independent variable is the environmentTest tube number/ -Environment/ -Change of colours of solution/ -3alcoholicslight purple4acidicstrong red5basicstrong yellowColour of chemicals used: absolute alcohol, hydrochloric acid and sodium hydroxide are colourlessDrawing 2. Observations of testing the cell membrane

permeability of red cabbage when the independent variable is the alcoholic, acidic, and basic environmentTable 3.

Observations of testing the cell membrane permeability of red cabbage when the independent variable is temperatureTest tube number/ -Temperature/ oCIntensity of purple colour/ -640 0. 5slight purple765 0. 5medium purple8100 0. 5strong purpleDrawing 3. Observations of testing the cell membrane permeability of red cabbage when the independent variable is temperatureTable 3. Observations of leaf discsTest tube number/ -Drawing of a leaf disc/ -12345678Random error:- the difference between the diameter of the leaf and the test tubes was very small, therefore the sinking or floating of the leaf discs could not be examinedThe use of pipette and thermometer cause systematic error, therfore- not 10 cm3, but 10 0.

5 cm3 was used- the water bath was heated to 40 0. 5 oCbut these data are part of the dependent variables. Maintaining the temperaure for tubes 6, 7 and 8 was not a source of error, because the tripod was moved from the fire and then moved back to maintain the temperature for two minutes. Conclusion and evaluation: The experiment showed that the first hypothesis is not supportive, because rinsing or not rinsing the leaf discs did not make any difference, so the amount of pigments released by the destroyed cells is very few, rinsing is needed to establish ceteris paribus, so examining the effect of only one varible, e. g. the action of hydrochloric acid.

The second hypothesis is supportive, because the experiment showed that as the temperature increases, the cell membrane becomes more and more permeable, and more pigments are released. The purple pigments can be

found in the vacuoles of the cells, surrounded by the internal and external membrane. The fundamental structure of the plasma membrane is formed by a phospholipid bilayer, that is, a double layer of phospholipid molecules arranged with their hydrophobic fatty acid tails pointing inward. The plasma membrane also contains numerous protein molecules, suspended in the bilipid layer. The proteins in the phospholipid bilayer denaturate at high temperature, as all proteins do.

The membrane warms up, and the phospholipid bi-layer becomes more fluid. At high temperature (100 oC) it is so fluid that large gaps appear on it, and the pigments are dissolved in the distilled water. The more pigment releases, the more the membrane is broken down. For temperature being the independent variable, test tube 2 was the contol test, beacuse it showed what happens (the disitlled water will not change colour) at room temperature, beacuse the hydrophilic heads face the water, and the hydrophobic tails face each other.

The carbohydrate legs of the hydrophilic part of the membrane kick out under certain conditions, e. g at certain pH levels. Red cabbage is used as a pH indicator, because for different pH levels, it results a different colour – for acidic the shades of red, for basic the shades of yellow, presuming after this experiment. Therefore another experiment should be done, in which the change of colour at different pH levels is examined. Alcohol showed that it cannot break down the membrane as much as e.

g. high temperature did, but it causes damage, resulting in a slight purple colour. For more accurate results, the experiment should be repeated more

times, or results of other students should be examined. To avoid the random error, the implement for cutting the red cabbage into discs should have a smaller diameter, or the diameter of the test tubes should be greater in order to examine the sinking of the leaf discs.