The book has two parts and twenty-six chapters: Part I titled "Physical Part" and Part II titled "Physiological Part." Part I focuses on Pfeffer's experiments with osmosis and is broken into parts A and B. Part A covers chapters one through six and discusses the apparatus and methods of the experiments. The first chapter describes the preparation of the cells, and chapter two discusses the measurement of osmotic water flow. Chapters three through five discuss the filtration, measurement, and calculation of pressure. Finally, chapter six is about the preparation and check of experimental solutions. Part B covers the experiments and conclusions in chapters seven through seventeen. The topics in these chapters cover different aspects of osmosis and osmotic pressure, including diosmosis of solutes, osmotic water flow, and osmotic pressure.

Pfeffer spends most of Part A describing the preparation of the technical apparatus and its measurements. He devised a new apparatus called the Pfeffer Zelle or Pfeffer Cell, a device used as a model for the plant cell and plant membrane in order to measure the amount of pressure within a plant cell. It contains a manometer used for measuring the pressure, a porcelain cell, and connecting and closing pieces. Pfeffer describes the process of preparing the Pfeffer Cell because he said it improved upon the devise and experiments of Traube, whose membranes often broke due to high pressures. Pfeffer discusses the treatment of the porcelain cells, which are necessary for the strength of the membranes, as well as copper ferrocyanide as a model for the plant membrane. He says that the amount of time needed to create the Pfeffer Cell helps to create a stronger device and helps
Part B covers many aspects of osmosis in plants. Pfeffer defines osmotic pressure as the equilibrium state between the inward flow of a fluid through a membrane toward a fluid of higher concentration, called endosmosis, and the removal of particles or molecules form a fluid as filtration. Endosmosis occurs when a fluid, which in plants is water, does not pass through a membrane and thus a force causes the flow of water through the membrane to reach equilibrium. Pfeffer explains that the experimental results may not give a definite account of the molecular structure of precipitation membranes, but they would enable scientists to follow the path of a solute through the membrane, which is the process of osmosis.

Pfeffer defines osmotic pressure as the point when equal quantities of fluid flow in and out of a membrane, or diosmosis. Osmotic pressure draws water particles into the interior of the cell along the same paths as those on which they filter outward under pressure. However, if a solute cannot pass through the membrane, then there is a unilateral water flow in which pressure pushes the fluid outward through the capillary space. Pfeffer states that his experiments proved the connection between osmotic pressure and diosmosis, but values of the pressure did not give a relative measure of the width of the pores in the membranes because the nature of the membrane material plays a role in the osmotic effect.

The "Physiological Part" or Part II of the book spans chapters eighteen to twenty-six. Some of the topics of Part II include the plasma membrane, the molecular structure, diosmosis through the plasma membrane, pressure relations in the cell, cell mechanics of movements, and some growth and formation processes. Chapter twenty-four is about plant development, titled &Some Growth and Formation Processes." This chapter relates the experiment with the Pfeffer Cell to the growth of the cell. Pfeffer explains that osmotic pressure seeks to expand the surface area of the cell wall and transversely compresses the cell wall to support layers of the cell. He describes this process as like a mass (or a sponge) that can swell and is then wrapped in a cloth and put in a press. The mass extrudes water until the external pressure is no longer capable of pressing out the stored water, which a greater force retains. The pressure within the cell expands the cell walls from within the cell and the pressure from outside of the cell, such as from surrounding cell walls, creates corresponding turgor pressures.

The cell wall increases in volume by swelling, and it retains absorbed liquids only after the pressure ends. With osmotic pressures come other processes, such as the material needed to form the cell wall. These materials must come through the plasma membrane in both dissolved and insoluble forms. Pfeffer says that the materials needed to form the cell wall must be in contact with an aqueous medium, with air, or another medium, but could not be isolated. He says that there are no facts available about the mechanical cause of the cell wall formation, so he stops the discussion with his conjecture that materials for the cell wall relate to osmosis.

Pfeffer next discusses the formation and distribution of the substances that mediate growth and locomotion of the cell, which are the accumulation of protoplasm in specific locations. Pfeffer says that researchers do not know how external influences affect formation of these substances, but he states that influences such as light, temperature, chemical reagents, gravity, and electricity influence movements in the protoplasm. He spends the rest of chapter twenty-four on chemical reactions that may affect the growth and morphology of the plant. For example, he explains that pressure on the plasma membrane due to a chemical reaction and hydrostatic pressure, which is the pressure equal to the force that the cell wall exerts when it forces water to leave the cell, may affect the plants growth. Even if the pressure is minimal, the pressure could gradually produce important morphological changes in the protoplasm, which would affect the plant cells overall.

Pfeffer's translators, Gordon R. Kepner and Eduard J. Stadelmann, discuss the impact of Osmotic Investigations in the introduction to their 1985 book. Kepner and Stadelmann note that Charles Overton, who studied cell membranes in Germany in the early 1900s, described the book three decades after publication as epoch-making, and that Pfeffer had received less than his due of credit. The translators state that they translated the book to disseminate Pfeffer's contributions and make available his authoritative and historically interesting commentaries on the mid-nineteenth century theories of the cell membrane and osmotic phenomena. Osmotic Investigations received some recognition after Jacobus van't Hoff, a 1901 Nobel Prize in Chemistry laureate, used Pfeffer's measurements to support his theory of osmotic pressure. The translators explain that Pfeffer's work was neglected because his writing was speculative and abstract.

Sources
