formations, north to north-west faulting, and silver–lead–gold mineralization.

Dr. T. L. Tanton offered a theory, based on a study of conchilites and the work of W. D. Francis, suggesting the steps whereby non-living matter may have evolved into semi-living organisms, which provided the catalyser for the synthesis of protein and the conditions that induced the evolution of primeval forms of life. Dr. M. L. Keith described brucite deposits in the Rutherglen District, Ontario. Franco Rasetti reported the discovery of Middle Cambrian fossils in the Gaspé, the first recorded in the Province of Quebec. Dr. R. F. Legget described the geology of the "Shipshaw" area on the Saguenay River, and reported finding wood and other organic matter imbedded in the clay. Peter Ginn described an ultrabasic rock near Lochalsh, Ontario.

Dr. Robert Newton, president of Section V, in discussing the northern limits of wheat production, pointed out that wheat production in Canada is mainly confined to the southern plains region of the Prairie Provinces. Its possible northward extension concerns not only the potential world food supply, but also the feasibility of northern settlement. The longer summer days of northern latitudes are favourable to growth, but their value is reduced by association with lower temperatures. Rainfall is another important modifying factor. Moreover, the milling and baking quality of northern wheat is generally inferior. This may not destroy its usefulness as a local food resource, but makes it unsuitable as an article of commerce.

Prof. R. B. Thomson, who was awarded the Flavelle Medal, presented a paper entitled "Food Supply and Budding or Twinning Embryogeny". Prof. Thomson believes that the view that the asexual type of embryo initiation involved in budding or twinning embryogeny is due to recent mutation is not supported by sufficient evidence; whereas that for its being an innate or constitutional potentiality is satisfactory. The expression of this potentiality, however, is generally kept under control as indicated by the prevalence of simple embryogeny (one embryo from one zygote) in the main lines of evolutionary advance. Thus the problem of accounting for the sporadic occurrence of budding or twinning at different levels in such advance is concerned with the elimination of established control. This has been effected in animals by various physical and chemical experimental procedures. Up to the present, however, little attention has been given to the influence of food supply, and some experimental and other evidence, particularly the effect of excess nutrition on the production of a free nuclear stage in embryos normally undergoing simple embryogeny, indicates the importance of giving more attention to the possibly broader significance of this factor.

Dr. W. H. Cook, director of the Division of Applied Biology of the National Research Council, discussed some of the War research projects of the Council under the title "Some Wartime Food and Supply Problems". Under war conditions the main problem in feeding civilian or Service personnel is that of transport and distribution, complicated by the perishability of many foodstuffs. To meet the emergency, facilities had to be improvised to preserve the product, or alternatively the foodstuffs themselves had to be rendered less perishable. The dehydration of foodstuffs rich in proteins and fats was discussed in relation to the measurement and maintenance of quality and the type of deterioration that occurs. Several new chemicals required by war industry can be provided by the fermentation of starch. Reference was made to the bacterial fermentation yielding 2,3-butanediol, a material readily converted to butadiene and other chemicals.

Thirty-eight other papers on various phases of biological and medical sciences made up the programme of Section V. These included an important communication by Dr. B. P. Babkin, describing the interference of quinine bisulphate with cholinergic mechanisms in the heart and stomach of the dog, and a demonstration by Dr. C. C. Macklin that venule capacity in the lung is increased on inspiration.

Fifteen new fellows were presented, including the following in the Scientific Sections: Section III (Chemical, Mathematical and Physical Sciences): R. Brauer, E. W. Hewson, O. J. Walker; Section IV (Geological Sciences): V. J. Okulitch, J. E. Thomson, H. V. Warren; Section V (Biological Sciences): E. W. Crampton, J. Labarre, W. Leach, C. A. Mitchell, A. W. H. Needler, D. Y. Solandt.

Officers for 1945–46 were elected as follows: *President*, Prof. E. S. Moore, University of Toronto; *Vice-President*, Prof. H. A. Innis, University of Toronto; *President of Section I*, Dr. S. Marion, Ottawa; *President of Section II*, Prof. D. C. Harvey, Dalhousie University, Halifax; *President of Section III*, Prof. C. T. Sullivan, McGill University; *President of Section IV*, Dr. B. R. MacKay, Ottawa; *President of Section V*, Dr. B. P. Babkin, McGill University.

MODE OF ACTION OF PENICILLIN

SOME of the more recent work on the mode of action of penicillin was briefly reviewed in *Nature* (**155**, 403, March 31, 1945). Work noted there established the fact that penicillin is not merely bacteriostatic but also can actively destroy some micro-organisms. This bactericidal effect appears to be exerted especially upon the young bacterial cell and upon feeding bacteria, and to be therefore conditioned by certain factors in their environment. A leading article in the *Lancet* (276, March 3, 1945) summarizes the facts about this question which were available up to that date.

Important recent papers have since appeared. Thus E. Chain and E. S. Duthie (*Lancet*, 652, May 26, 1945) point out that Fleming, in his original paper on penicillin, recorded its slow bactericidal effect on *Staphylococcus* and its lytic effect under certain conditions. They explain that the original statement by the Oxford workers that penicillin is mainly bacteriostatic was based on the fact that it did not affect the oxygen uptake of resting *Staphylococcus*, for large numbers of viable colonies were found after incubation with penicillin in Ringer solution for twenty-four hours. They then review work done in the United States, which demonstrated that penicillin is bactericidal, but that it is not so under unfavourable conditions (such as low temperature or exhausted media) and that its bactericidal effect can be increased by substances which enhance bacterial growth and decreased by substances which interfere with bacterial growth (for example, sulphadiazine). From the results of their own work recorded in this paper, Chain and Duthie conclude that, during the resting phase of *Staphylococcus*, even large concentrations of penicillin have no effect on the oxygen

uptake. During the early lag phase, however, and during the logarithmic phase of multiplication, penicillin has a strong inhibitory effect, and eventually completely stops the oxygen uptake, even in small concentrations (0·04–0·1 units per c.c.). They also demonstrated a strong bactericidal effect in the early lag phase and the logarithmic multiplication phase, but no measurable bactericidal effect during the resting phase. This confirms American work. Chain and Duthie conclude that penicillin can exert a bactericidal effect on *Staphylococcus* before actual division occurs, but that the organism can undergo at least one division in the presence of penicillin when it is added during the logarithmic phase of multiplication. It appears to interfere with some metabolic function of the early stages of bacterial development. Helvolic acid, the bacteriostatic antibiotic, antagonizes the bacteriostatic and bacteriolytic action of penicillin. Sulphanilamide and sulphamezathine, on the other hand, do not prevent the occurrence of several bacterial divisions and have no antagonistic effect on the bactericidal effect of penicillin on *Staphylococcus* and *Streptococcus*; on the contrary, they have a synergistic effect.

Chain and Duthie compare the modes of action of penicillin and the sulphonamides and review some of the literature upon this subject. They conclude that penicillin can kill *Staphylococcus* in the early lag phase before cell division has occurred, while sulphonamide kills only after several divisions have taken place in its presence. These results may be compared with those obtained by W. S. Miller, C. A. Green and H. Kitchen (*Nature*, **155**, 210, Feb. 17, 1945), who estimated the growth of the Oxford *Staphylococcus* turbimetrically in the presence of penicillin and sulphonamides and also discuss the effects of these two kinds of substance. They suggest that confusion may arise in discussions of bacteriostatic and bacteriolytic action because too fine a distinction is drawn between these two modes of action. Both penicillin and sulphonamides act by inhibiting cell multiplication; but, while sulphonamides inhibit the growth of almost every kind of cell as well as that of bacteria, there is little evidence that penicillin does this. Additional knowledge of the chemistry of penicillin may reveal that its mode of action is, like that of the sulphonamides, related to its chemical structure. It is unlikely that the mode of action of penicillin is unique; it is more likely that it differs from that of sulphonamides only in degree.

P. Bonét-Maury and R. Pérault (*Nature*, **155**, 701, June 9, 1945), using the differential photometer at the Radium Institute, Paris, suggest that, whereas the sulphonamide used by them (Dagenan 1162 F) does not stop but delays proliferation of *Staphylococcus aureus*, penicillin stops proliferation almost immediately, even at low concentrations, and that lysis follows. They found, however, that later a second proliferation occurred regularly, followed by a second partial lysis and then a second post-lytic growth. These results recall those obtained by J. W. Bigger (see *Nature*, **155**, 403, March 31, 1945). Bonét-Maury and Pérault obtained their results with six different penicillins (English, American and French). J. Hirsch (*C.R. Ann. Soc. Turque des Sci. Phys. et Nat.*, **12**; 1943–44) also studied the action of penicillin *in vitro* by manometric methods, and his work is discussed by Chain and Duthie (*loc. cit.* above). R. Knox (*Lancet*, 559, May 5, 1945) also concludes that the action of penicillin can be bacteriostatic, bacteriolytic or bactericidal, and that the young bacterial cell is particularly susceptible to penicillin. A. B. MacGregor and D. A. Long (*Nature*, **155**, 201, Feb. 17, 1945), studying the action of penicillin in relation to their work with penicillin pastilles (see *Nature*, 341, March 17, 1945), conclude that penicillin is bactericidal as well as bacteriostatic.

Very instructive also is the direct microscopical observation by Prof. A. D. Gardner (*Lancet*, 658, May 26, 1945), whose earlier work (*Nature*, **146**, 837; 1940) suggested that weak penicillin inhibited growth but did not prevent it, on the effects of penicillin on the spores of *B. anthracis* and *B. subtilis*. Gardner found that strong penicillin (50–100 units per c.c.) slowly kills the spores. Those of *B. anthracis* were more susceptible than those of *B. subtilis*, but neither were completely eliminated and there was no gross swelling. The spores gradually lost their high refractility and became empty ghosts. Weaker solutions of penicillin (0·1–1·0 units per c.c.) allowed the earliest phase of germination to occur, and the spores of *B. anthracis* then swelled up and became spherical coccoids which burst. Those of *B. subtilis* underwent similar changes, but all were not killed. Nevertheless, even the weakest inhibitory dose of penicillin renders the great majority of the spores non-viable. Spores studied in non-nutrient media were, however, little if at all affected, even by strong concentrations of penicillin, so that penicillin acts upon feeding bacteria and its action begins directly the bacteria begin to feed. Prof. Gardner concludes that the action of penicillin on sensitive species has little or no connexion with multiplication or division, although penicillin did cause abnormal divisions in sensitive *S. typhi* (long waists, spindle-shaped swellings, etc.). The majority of *Staphylococcus aureus* and *Streptococcus pyogenes* growing on agar are checked or killed before any visible growth or division has occurred. These conclusions, based upon direct microscopical examination, must carry great weight. It would seem that what is now required for a better understanding of the mode of action of penicillin is more exact knowledge of the chemistry of penicillin and the correlation of this, by the methods now being used for the biochemical analysis of micro-organisms, with the enzyme systems and other metabolic features of the organisms concerned.

G. LAPAGE.

RADIO WAVES FROM THE SUN

As the technique of radio-frequency measurement and application has progressed to successively higher frequencies, various investigators have from time to time turned their attention towards a demonstration of the interchangeability of thermal and radio methods of detecting electromagnetic waves. The use of normal radio receiving technique to detect thermal radiation from a hot body has always been an attractive line of experiment; and for this purpose, the sun, in spite of its great distance away from the earth, would appear to offer considerable advantages as a source of radiation of the desired type. The practicability of the reception and measurement of so-called 'cosmic noise' on an ordinary radio receiver has been demonstrated in various investigations, notably those described during 1932–39 by K. G. Jansky, who worked on frequencies of the order of 10–20 megacycles per second, and later (1940–44) by G. Reber, who described corresponding measurements made at frequencies of 160 Mc./s. In these cases, the