new kind of statistics for electrons (Fermi-Dirac statistics). He applied this to the assemblage of electrons in an atom (Thomson-Fermi atom model), and it has become the basis of the modern theory of electrons in metals. In 1934 he devised a theory of β-decay, starting from the view that a β-particle is emitted when a neutron in the nucleus turns into a proton. The distribution of energies in a continuous spectrum requires that a neutral particle (neutrino) be emitted with the β-ray. This theory has formed the starting point for many more recent discussions. Fermi has also published work on spectroscopy, on quantum electrodynamics, and, with Rossi, on the deflection of cosmic rays in the earth's magnetic field.

Dr. W. D. Lang, F.R.S.

Dr. William Dickson Lang, who retires from the keepership of geology in the British Museum (Natural History) at the end of the year, has made notable contributions both to palæontology and to geology. While occupied with curatorial duties he has studied especially polyzoans and corals, and in classifying them he has always sought for underlying principles. Like palæontologists studying other groups, he soon recognized parallel lineages in the evolution of these fossils as he traced them through geological time, and he found corresponding grades in the same order in each parallel lineage, showing that there was a definite common trend, as he termed it. Natural selection, therefore, did not work on indefinite individual variations but on trends which were 'orthogenetic' or in a certain fixed direction. Dr. Lang contributed several valuable papers on this subject to the *Proceedings of the Geologists' Association*, and he summarized his results in discussions at the centenary meeting of the British Association in 1931.

Dealing with animals which retained the complete skeleton of a lifetime in each individual, Dr. Lang could also study the growth stages, and he was convinced of the truth of the doctrine of recapitulation (the immature stages of an organism repeating more or less exactly the adult stages of its ancestors). He described it as "a guiding principle" for palæontologists. Dr. Lang also recognized that the calcareous skeleton of the polyzoans, when once started in a lineage, often proceeds to superfluity and eventually leads to extinction. He treated this subject in a memoir in the *Philosophical Transactions* in 1919, and in two valuable volumes of the British Museum Catalogue of Cretaceous Polyzoa, 1921–22. Dr. Lang spent many vacations in studying the succession of zones in the Lias of the Dorset coast. In 1924 he contributed to the *Proceedings of the Geologists' Association* a remarkably detailed map of these formations, and during more recent years he and other specialists have made a detailed examination of the fossils he collected. His interests have always been varied, and during the Great War he investigated insects which spread disease, eventually preparing an exhaustive "Handbook of British Mosquitoes", which was published by the Trustees of the British Museum in 1920.

Prof. A. V. Hill, O.B.E., F.R.S.

The Guthrie Lecturer of the Physical Society this year was Prof. A. V. Hill, Foulerton research professor and secretary of the Royal Society, who chose as the title of his lecture delivered on November 11 "The Transformations of Energy and the Mechanical Work of Muscles". Prof. Hill is a Cambridge man, where, under Langley, he devoted two years to research on the heat produced by living tissues. Here Hill found a congenial and stimulating environment, for those working in the laboratory at the time included such well-known figures as Anderson, Barcroft, Fletcher, Hardy, Hopkins and Keith Lucas. Prof. Hill's success may be said to be due to his appreciation of the basic essentials of a problem, to his knowledge of the methods by which such problems may be solved, to his ability to design the apparatus required by such methods, and lastly to his skill in constructing the necessary apparatus himself. A first-rate athlete, he was specially interested in the physiology of athletics. It was he who showed that energy is developed in muscle at two different times during a single contraction. Two pieces of apparatus have entered largely into these studies, namely, extremely delicate thermopiles and galvanometers which have a short period and great sensitivity. While the study of energy of contraction of muscle has been Hill's main line of research, a number of branch lines have interested him from time to time, mostly on biophysical subjects; for example, the measurement of small differences of osmotic pressure and the heat produced in nerves during the passage of impulses. During the Great War, Hill was director of research on anti-aircraft defence. In 1920 he became professor of physiology in Manchester, and in 1923 professor of physiology at University College, London. Prof. Hill has been honoured by several foreign universities and learned societies, and in 1922 he received the Nobel Prize for Medicine.

Energy Transformations in Muscles

In his Guthrie Lecture on the subject, Prof. A. V. Hill pointed out that the study of the heat given out by muscles in relation to the work done by them is one of the classics of physiology. Until recently, however, the matter appeared much more complicated than it really is, owing to technical difficulties. These have been overcome by the use of a very rapid recording system and an insulated thermopile only 0·002 inch thick. Some very simple relationships have now emerged. An active muscle liberates energy in three forms: in maintaining a contraction, as heat; in shortening, as heat; in shortening against load, as work; its behaviour in any circumstances is deduced from the resultant of these three. *Rate* of total energy liberation of a muscle is determined by the load upon it, increasing as the load decreases. This allows a simple equation to be deduced for the relation between speed and load. The constants of the equation are the same whether they are obtained by thermal or by mechanical measurements. The fact that a muscle does less external work when shortening at a higher speed has led to the hypothesis that muscle is endowed with 'viscosity', attributed to a lag in the rearrangement of its molecules, as the external form of the contractile elements changes. This viscosity hypothesis is, however, altogether unnecessary; for the decrease of force and work with increased speed can be deduced from the manner in which the energy liberation is regulated. Some applications were also described. The maximum power developed by a muscle is with a load about three tenths of the maximum load it can bear. The highest efficiency (work/total energy) is with a load of about 0·45 of the maximum. These are near enough for maximum power and maximum efficiency to occur very nearly at about 37 per cent of the maximum load. These results obtained with frog's muscle almost certainly apply, though possibly with different constants, to man, and it would be very important to find out and to determine the constants of human muscle. The technique required would be a very different one.

Anthropoid Evolution in South Africa

Dr. Robert Broom continues to provide sensational news from South Africa for anthropologist and palæontologist. In another column of this issue (see p. 897) he reports further finds of relics of South African fossil anthropoids, which, if anything, surpass in interest the remarkable discoveries he has already recorded recently in these columns. From the site on which was found the Kromdraai skull, he has now recovered three bones, or parts of bones, the right humerus, the ulna and one of the toe-phalanges of *Paranthropus*, which, as his nomenclature indicates, he places, on the evidence of the skull, very near the line of man. The new evidence fully bears out his conclusion, for as he states, these bones, which on the balance of probabilities must be associated with the skull, are "nearly human". Further, and this is the most interesting feature of the discovery, they, and more especially the toe bone, must be interpreted as pointing to *Paranthropus* having walked erect. In other words, the upper limbs of this type were already freed from the duties of locomotion to undertake those functions which were to play a predominant part in forwarding the development of the specific characters of the brain of *Homo sapiens*.

This eminently reasonable interpretation of the Kromdraai finds removes the element of surprise from the further discoveries from Sterkfontein, which Dr. Broom records; but it adds to their significance in mutual corroboration as between the two series of discoveries. At Sterkfontein, on the site on which he had previously discovered *Plesianthropus transvaalensis*, an advance towards the human on Prof. Raymond Dart's *Australopithecus*, or ape-man from Taungs, Dr. Broom has also found the distal end of a femur and part of the brain cast of, it is argued, a mature male. Not only would the fragment of femur suggest that this type of fossil anthropoid also had attained bipedal status, but in addition the brain cast, when reconstructed, would place the capacity of the brain of *Plesianthropus* next in the scale of measurement, so far as at present known, to the recently discovered specimen of *Pithecanthropus* from Java. *Pithecanthropus*, no longer in danger of being classed as a gibbon, is definitely above the human border-line. The new evidence from Kromdraai and Sterkfontein, taken in conjunction with the evidence of the symphyses, which Dr. Broom further records, would indeed seem to afford warrant for the view that we have been given a glimpse of the evolutionary process at a moment when what has been regarded hitherto as man's prerogative, the permanent assumption of the erect posture, had not long taken place. The difficulty in the way of regarding the South African fossil series as forming part of the human evolutionary process, though of course significant by analogy, on the ground of its relatively late date, to which Sir Arthur Keith has directed attention, is reduced, though not eliminated, by Dr. Broom's evidence for a revised dating.

Scientific Associations of the Lubbock Estate

The public acquisition of the High Elms estate in Kent, as part of London's 'green belt', is an event of note in the history of science; for this was the home of the Lubbock family from 1808. In that year, Sir John William Lubbock acquired the nucleus of the property, some 270 acres; by later accretions the estate reached its present extent of nearly a thousand acres. A second Sir John William Lubbock was the first to bring scientific fame into the annals of the family: his observations of tidal and lunar phenomena and in physical astronomy ranked him high, and he was elected fellow of the Royal Society when barely twenty-seven years old. He worked also on the mathematical doctrine of probability and applied it practically to the subject of life assurance. He became the first vice-chancellor of the University of London. He built the present mansion of High Elms, extended the property, and greatly beautified it by planting many of the splendid trees which grace it now. He was followed by a still more famous son, Sir John Lubbock, afterwards Lord Avebury, who, born in 1834, spent nearly all his life there, and succeeded to the property in 1865. It is well known that on the scientific side his extraordinary career was influenced, not only by his father, but also, profoundly, by Charles Darwin.

In fact, the assurance of the preservation of High Elms rounds off, as it were, a unique scientific memorial. For Down House is less than two miles from High Elms, and Down House, as is well known, is preserved as a memorial to Darwin by the gift of Sir Buckston Browne to the British Association. It is on record that Sir John William Lubbock hailed as a great event the news that Charles Darwin was coming to live at Down House in 1842, and it was not long before intimacy was established between the two houses. Between Darwin, in his thirties, and John Lubbock, not yet in his teens, a close friendship grew and endured until Darwin's death in 1882, when Lubbock paid final tribute to his scientific master by drawing up the memorial which petitioned the Dean of Westminster that Darwin should be buried in the Abbey. It is good to know that not