absorption followed the same law, he had worked out some results for the earth's atmosphere. If the atmosphere were of uniform constitution, so that the absorption by a layer of air of given mass was the same at whatever height the layer was taken, then the state of convective equilibrium could not exist to heights greater than those corresponding to a pressure equal to half the surface pressure. He found that for greater heights than this the radiation absorbed from the earth and the rest of the atmosphere alone was greater than that emitted at a temperature corresponding to the state of convective equilibrium. In consequence of this the temperature of the air in the upper layers would rise, and there would be a further increase owing to the absorbed solar radiation. In the actual case, the absorbing power of the atmosphere diminishes with increasing height owing to the diminution in the proportional amount of water vapour present. The absorbing power was therefore taken to be equal to $a/(q-p)$, where a and q are constants. Two values were taken for q, for one of which the diminution in absorbing power was quicker, in the other slower, than the diminution in the proportion of water vapour present. The value of a was deduced from the observations of Langley, Paschen, and others.

The conclusions arrived at were:—

(1) If the temperature gradient in the lower layers of the atmosphere is such that $T \propto p^{\frac{2}{7}}$, *i.e.* is approximately adiabatic, and if the upper layer is isothermal, then the state $T \propto p^{\frac{2}{7}}$ must extend to a height greater than that for which $p = p_0/2$, and in general less than that for which $p = p_0/4$, where p_0 is the surface pressure.

(2) The temperature in the lower layers cannot be maintained by absorption of terrestrial and solar radiation; these layers tend to grow cooler, and their temperature is kept up by the supply of heat through convection from the earth's surface and by condensation of water vapour in the atmosphere.

(3) The lowest possible temperature in the atmosphere over a place at temperature 300° A. must be greater than 150° A. or 210° A., according as the atmosphere radiates and absorbs throughout the spectrum or transmits freely 25 per cent. of the earth's radiation.

Prof. Turner said that whereas meteorologists were perhaps primarily concerned with the facts themselves, and physicists with the causes of them, astronomers were interested in the effects of the existence of this isothermal layer, especially in the phenomena of atmospheric refraction. It had been usual to make certain assumptions about the upper air for the calculation of refraction, and these assumptions were now shown to be wrong. Were the refractions calculated on such assumptions wrong? The answer seemed to be that very rough assumptions were sufficient for astronomers; he had found, for instance, that the assumption of two homogeneous shells of air would give empirical results corresponding closely to the facts observed.

Further, no very great improvement was found by adding a third shell—the chief step came in taking two instead of one. Possibly this fact (that two shells were absolutely necessary, but a third was not so much needed) was in some way connected with the existence of two principal regions in the atmosphere.

Prof. J. J. Thomson asked if there was any indication of the thickness of the layer, and remarked that the ionisation in the atmosphere was a maximum at a layer considerably below this layer.

Dr. Walker stated that the Indian peasants were so ignorant that he had not yet ventured on sending up *ballons-sondes* there, the chances of recovering them being so remote.

THIRD INTERNATIONAL CONGRESS FOR THE HISTORY OF RELIGIONS.

OXFORD has good reason to be proud of the success of the congress, which was held there from September 15 to September 18; not only was the general level of the papers high, but the attendance of members—nearly 600—was so large that the Transactions will contain, besides the presidential addresses, some of the more important papers in full, with an abstract of the remainder. The total number of papers was well over 100, hence the need for limitations.

At an Oxford congress of religions it was natural that a part should be played by the Father of Anthropology, and the enthusiasm with which Dr. Tylor was greeted when he introduced the president, Sir A. C. Lyall, was as flattering a tribute to his greatness as he could desire. The subject of Sir A. C. Lyall's address was religious conflicts and the conditions under which one religion attained predominance over its competitors; he held that State recognition has been indispensable to religious consolidation, and ascribed to the absence of State regulation the freedom characteristic of Hindu theology.

The congress was divided into nine sections, besides a general one for papers of wider import, and in each section a presidential address was delivered; Sir John Rhys dealt with Celtic religion, and pointed out that our evidence was precarious, and our knowledge inferential only; Prof. Giles said that the Chinese had a sky-god, Tien, who received, however, neither respect nor sacrifice; eventually this power became an abstraction; Mr. Hartland discussed, among other things, magic, a subject also dealt with by Dr. Jevons; Prof. Petrie discussed Egyptian religion, and pointed out that the prominence of the funerary cult in it was accidental and due to the rise of the bed of the Nile, which had covered up the Egypt of the living; in the life of the ordinary man, the local sacred animal or totem figured largely; the murder of a cat would have set Alexandria in flames, even down to Roman times.

Of the other papers, some were sensational, like that of Prof. Haupt, who maintained the non-Semitic descent of Christ; he argued that Galilee was denuded of Jews in 164 B.C., and that when the Jewish religion was reintroduced fifty years later, it was imposed on Assyrian colonists introduced by Tiglath Pileser; an effective criticism on this view was made by Dr. Gaster, who pointed out that the Jews would have been ready enough to seize on a much less valid ground for denying Christ's descent from David.

Dr. J. G. Frazer also dealt with Jewish beliefs, but his notes on them were the wonderful collections of parallel instances from all parts of the world which we expect from him; he traced the silent widow, for example, in North America, Madagascar, and Australia, where a two years' ban rests upon them, and has been perhaps a potent cause in the development of gesture language.

Dr. A. J. Evans read a paper on the cults of Minoan Crete, and pointed out that recent discoveries corroborated the views which he put forward in 1900; Minoan cults were predominantly aniconic, though images were also found; the cult objects were trees and pillars, and the double axe; the principal divinity was a nature goddess. As a pendant to this paper may be mentioned Miss Harrison's discussion of bird and pillar cults, in which she argued that the change from the "matriarchal" to the "patriarchal" stage caused a change of sex in the most important divinity.

Anthropologists are far from being agreed as to the definition of religion, and, not unnaturally, there was an attempt to define it in the section devoted to religions of the lower culture. Mr. Marrett held that Tylor's animism was far wider than religion, though it did not embrace all religion; the real criteria were two—first, the presence of *mana*, magico-religious force, and, secondly, the negative rites set up by a belief in *mana*, and commonly known as tabu; when the personal element became prominent in religion, animism came in; but it is really a primitive philosophy far wider than the supernatural.

Special interest attached to Dr. Seligmann's account of the Veddahs, from whom he has just returned; with them, as with many other races, fear was the main emotion, and at death they deserted the cave, leaving the body without food or fire; the cult of the dead was almost the central feature of the psychical life of the Veddahs. Funerary customs were also dealt with by Mr. T. C. Hodson in a paper on the Assam hill tribes, and by Mr. N. W. Thomas; the latter summarised Schmidt's views, as yet unpublished, as to the three strata in the population of Australia—old and new Australian and (?) Papuan—and pointed out that the burial customs largely followed the linguistic lines; in the south and west of Australia fear of the dead was found, and disposal of the body once for all; in the north and east the flesh was removed from the bones, and only with the burial of the latter was the spirit supposed to be dismissed to its own place; in the south the grave was the abode of the spirit.

Mr. W. W. Skeat's paper dealt with traces of totemism in the Malay Peninsula; totemism implies a group name, a belief in group kinship, and respect for "the blood," and of these the second is the primary one from which the others have sprung; but he was inclined to hold the view that totemism was originally independent of the notion of kinship; the Semang have not, as contended by Mr. Gomme, plant totemism, for plant names are far from general.

Among other papers may be mentioned one by Mr. Hollis on the Nandi, which suggests that their religion is a cross between Bantu ancestor cult and the Masai sky-god cult.

The social side of the congress was well looked after, and receptions were given by Prof. Gardner and Dr. Evans at the Ashmolean, Mr. Marrett and Dr. Farnell at Exeter, Profs. Driver and Sanday at Christ Church, Prof. Carpenter at Manchester College, and by the Mayor and Mayoress.

THE BRITISH ASSOCIATION.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY J. S. HALDANE, M.D., F.R.S., FELLOW OF NEW COLLEGE AND READER IN PHYSIOLOGY IN THE UNIVERSITY OF OXFORD, PRESIDENT OF THE SECTION.

The Relation of Physiology to Physics and Chemistry.

IN choosing to address you on the relation of Physiology to Physics and Chemistry, I am aware that I have selected a subject which has already been treated from this chair by more than one distinguished predecessor. My excuse for returning to it again is that it not only possesses deep scientific interest for us all, but that a great deal remains to be said about it.

The majority of physiologists in recent times have expressed more or less clearly the opinion that Physiology is the application to living organisms of the methods and modes of explanation of Physics and Chemistry. It is, in short, Physics and Chemistry applied to the activities of living organisms; so that the only explanations aimed at in Physiology are, or ought to be, physical and chemical explanations. A minority, which is at present a growing one, I think, have either definitely dissented from this view, or have remained unconvinced of its truth. As one of this minority I should like to place before you as shortly as possible what seem to me to be the main reasons of our dissent. Let me add that I have carefully pondered over these reasons during many years of active physiological work.

When we look back on the history of Physiology is seems perfectly evident that physiological progress has been dependent on the progress of Physics and Chemistry. On this point there is no room for doubt. To take only one example, where should we be in the investigation of animal metabolism but for the ideas and experimental methods furnished to us by Physics and Chemistry? We should know next to nothing about respiration, animal heat, nutrition, or muscular and other work. Physiology depends at every turn on Physics and Chemistry, and its future progress will certainly be equally dependent on advances in physical and chemical knowledge. This consideration has, I imagine, weighed very heavily in the minds of those physiologists who have concluded that Physiology is nothing but applied Physics and Chemistry. A further fact which weighs equally heavily is that in spite of diligent search no fact contradicting the fundamental laws of conservation of matter and energy has been discovered in connection with living organisms.

When, however, we ask what progress has been made towards the physico-chemical explanation of physiological processes, we at once enter upon controversy. We may point to advances in some directions, but they are accompanied by the appearance of unforeseen difficulties in other directions. Again, to take animal metabolism as a typical instance, the investigations of the last hundred and twenty years have enabled us to assign ultimate physical and chemical sources to the energy and material leaving the body in various forms. We can assign to such sources the energy of animal heat, muscular work, glandular, nervous, and other activity: also the carbon dioxide, urea, salts, and many other substances which leave the body or are formed within it. All of this new knowledge may be regarded as progress towards a physico-chemical explanation of life.

But there is another aspect to be considered; for side by side with what I have just referred to there has been a different kind of increase of knowledge with regard to animal metabolism. This growth of knowledge relates to the manner in which the passage of energy and material through the body is regulated in accordance with what is required for the maintenance of the normal structure and activities of the body. In Liebig's time, for instance, it was believed that the rate of respiratory exchange was regulated simply by the supply to the body of oxygen and food-material. If one breathed faster, or if the barometric pressure or percentage of oxygen in the air increased, the respiratory exchange was assumed to be also increased, just as ordinary combustion outside the body would be increased by an increased supply of oxygen. If, again, one took in more food it was supposed that the excess went to increase the rate of combustion in the blood (*luxus consumption*), just as a fire is increased when more fuel is supplied. We now know that these assumptions were wholly mistaken, and that the respiratory movements, respiratory exchange, and corresponding consumption of food material in the body are regulated with astounding exactitude in accordance with bodily requirements. If, for instance, the body consumes more proteid, it economises a quantity of fat or carbohydrate equivalent in energy value to the proteid; and from day to day the amount of energy liberated in the body is very steady. With regard to the excretion of material by the kidneys a similar growth in knowledge can be traced. It is scarcely a century since the urine was regarded as equivalent more or less to the liquid part of the blood separated from the corpuscles, which were unable to pass through the very fine capillary tubules supposed to exist in the kidney substance. Gradually, however, we have learnt how extraordinarily delicate is the selective action which occurs in the kidney substance, and how efficiently this selective action maintains the normal composition of the blood. Scarcely a remnant is now left of the old filtration theories. Our ideas of tissue nutrition and growth have undergone a similar change; and it is hard to realise that only about seventy years ago Schwann could put forward the theory that cell formation and growth is a process of crystallisation.

One can multiply instances like these almost indefinitely; but I have, perhaps, said enough to show that if in some ways the advance of Physiology seems to have taken us nearer to a physico-chemical explanation of life, in other ways it seems to have taken us further away. On the one hand we have accumulating knowledge as to the physical and chemical sources and the ultimate destiny of the material and energy passing through the body; on the other hand an equally rapidly accumulating knowledge of an apparent teleological ordering of this material and energy; and for this teleological ordering we are at a loss for physico-chemical explanations. There was a time, about fifty years ago, when the rising generation of physiologists in their enthusiasm for the first kind of knowledge closed their eyes to the second. That time is past, and we must once more face the old problem of life.

Let us first look at the answer given to this problem by many of the older physiologists. Roughly speaking, they carried physical and chemical explanation of physiological processes as far as they could, and for the rest assumed that at some point or other the physical and chemical factors are interfered with and ordered in a teleological direction by something peculiar to living organisms—the "vital principle" or "vital force." This theory, if one can call it a theory, had the negative merit that it did not lead physiologists to ignore facts which they could not explain. But in practice the "vital force" became simply a convenient resting-place for these facts. It was assumed that the vital force could do anything and everything, and