life, and no diet is complete without them. If the brain, "one of the three legs of the tripod of life," is starved by a vitamineless diet troubles of all kinds—called by Funk *deficiency diseases*—arise, and these may end in death. The muscles dwindle away, the nerves degenerate, and heart and bone troubles result. Their absence is a predisposing cause of tuberculosis. Vitamines are found in plants, and especially in their seeds. So far as is known at present, animals are incapable of making them. Animals, however, obtain them by feeding on plants. Thus vitamines occur normally in meat, fresh milk, and yolk of egg. They are soluble in water, and insoluble, mostly, in ether. They are thermolabile, and are destroyed by exposure for 10–20 minutes to a temperature of 120°–130° C., as well as by extreme dryness. Thus cattle may, following on a long drought, suffer from a vitamineless fodder.

Funk regards vitamines as the mother-substance of ferments and hormones, and of vital importance to the thyroid and other ductless glands. It is thus evident that the diet standards of the text-books must be revised in the light of their discovery, which throws a flood of light on the milk and other food problems. White flours and corn flours are deficient foods because the vitamines have been removed in the milling process.

Wherever any cereal, robbed of its aleurone or vitamine layer, forms the chief food of a people, there a deficiency disease appears. Rice is eaten by more people than any other grain, in the tropical regions of both hemispheres. The marked increase of beri-beri caused by eating *polished* rice, claiming thousands of victims yearly in Japan, etc., coincides with the replacement of the primitive whole-grain stone-milling by the modern steel roller. The United States Government has already made the polishing of rice in the Philippines illegal. Indian corn (*Zea mais*) is largely eaten in north Italy, the Balkan provinces, the southern part of the United States, Brazil, etc. In all these countries pellagra, which affects the skin, digestive organs, and mental powers, is prevalent. The disease could be stamped out by adding to the diet potatoes, one of the cheapest and most practical sources of vitamines. Though the tax of 32*s*. 6*d*. a ton on potatoes has been removed, the U.S. Government has at the same time closed its ports to European potatoes, as a precaution against the introduction of potato diseases, such as Spongospora, though pellagra is on the increase, and American potatoes are becoming dearer.

Rickets, scurvy, osteomalazia, etc., are also deficiency diseases caused by the use, as the main articles of diet, of such vitamineless foods as sterilised milk, condensed milk, cornflours, starch, and sugar. The mixed diet of most people protects them from deficiency diseases.

Vitaminous foods are fresh milk and (though less rich in them) pasteurised milk, whole grains, potatoes, carrots, and other fresh vegetables, lime and other fruit juices, beans, peas, lentils, and the like, meat, beef-tea, barley-water, yeast, and apparently cod liver oil The discovery of vitamines leaves the vexed question of the relative values of white bread, standard bread, etc., where it was, as the heat of the oven, far above that of the autoclave in milk sterilisation, probably destroys the vitamines of the wholemeal bread.

*Phaseolus mungo*. L. (*P. radiatus*, L.), added to polished rice effectively supplies the removed vitamines, prevents beri-beri, and has long been regarded by the Chinese as a delicacy in the form of vermicelli. A yeast extract is already available for a similar purpose in this climate.

## ATMOSPHERIC REFRACTION AND GEODETIC MEASUREMENTS.[1]

AMONGST the many perplexing problems with which geographical surveyors have to deal those which concern the determination of altitude are not the least. For purposes of practical ability, such as the levelling of roads or the laying out of contours and gradients where differential altitude is comparatively small and progressive, existing methods are quite sufficiently scientific and accurate. It is in the determination of the relative altitudes of large geographical features, where angular measurements become necessary, that there arises a series of complications due to variations in the amount and effect of refraction, or in that of the plumb-line deflection, which have been by no means exhaustively investigated, and which introduce errors of an appreciable quantity. These errors are seldom of large practical importance, so that an investigation into their origin and the scientific methods of their dispersion is more or less matter of academic interest to that limited public which concerns itself with mountain altitudes and is generally content to accept the reading of a cheap aneroid as sufficient proof of the correctness of a value determined by triangulation.

By the scientific geodesist, however, Mr. Hunter's investigations will be warmly appreciated. The book before us is No. 14 of the Professional Papers of the Survey of India, and it contains a careful analysis of the chief sources of error which beset the ordinary estimates of the amount and effect of terrestrial refraction. The error due to refraction is usually disposed of by the assumption that the angle of refraction bears a constant ratio to the angle contained by the ray of observation at the centre of the earth. When reciprocal observations can be taken (*i.e.* from A to B, and from B to A) this ratio can be determined, and it is then recorded as the "coefficient of refraction," and is applied to other observations which, not being reciprocal, require to be corrected for the effect of refraction. This method Mr. Hunter calls a "makeshift," and it is with the object of putting the consideration of "angular measurements affected by terrestrial refraction on a more accurate and scientific basis," that he has deduced formulæ from his investigation which, in the concrete form of tabulated corrections, may assist in dispersing the errors arising from variations in the density, temperature, and atmospheric pressure of the air between the station of observation and the point observed. The only assumption which he makes is the natural one that "layers of equal density in the air are concentric with the (circular) section of the earth in the azimuth of the ray," an assumption which includes that of thermal equilibrium. The formulæ derived in chap. i. show that refraction depends very largely on the rate at which temperature changes with the height, and with the change of this rate, as well as on the differential height to which the ray extends. Mr. Hunter confirms the accepted rule that refraction is least in the middle hours of the day, but he further regards its variations as seasonal, *i.e.* it is least in the springtime of the year.

But when all is said and done, it is the errors arising from the deflection of the plumb-line (not always ascertainable at the point of observation), and the possible variation in the actual height of the point observed (common enough in the case of snow-capped peaks), which chiefly affect the accuracy of angular determinations of altitude, and it is probably to these rather than to the unequal conditions affecting the

[1] "Formulæ for Atmospheric Refraction and their Application to Terrestrial Refraction and Geodesy." By J. de Graaff Hunter.

intermediate stratum of air that we must ascribe (*exempli gratia*) the doubt whether Kinchinjunga or $K_2$ is to hold the honourable position of second in altitude to Everest amongst the world's highest peaks. T. H. H.

## REPORTS OF MUSEUMS.

THE report of the Bristol Museum for the year ending September 30, 1913, records praiseworthy activity, especially in the department of vertebrate zoology. Three plates show how attractively some of the more important specimens are displayed. A tiger shot by the King in Nepal, and presented by his Majesty, has been set up by Messrs. Rowland Ward, in a crouching attitude among bamboo stems, while the background, painted by Mr. Stanley Lloyd, shows the shooting-party approaching on elephants in the distance. Three springboks are placed near the margin of a veldt, on which other animals are browsing; this background was painted by Mr. G. E. Butler. The picturesque group in which pheasants are feeding (harmlessly) in the stubble, is backed by a view of Ashton Park, with the Clifton Suspension Bridge in the distance, composed by Mr. A. Wilde Parsons. This utilisation of really competent artists is an example to be followed. The geological department has not shared in the general progress, and considering the recent work of Vaughan and others in the west of England, this fact is rightly deplored by the committee.

With the aid of local naturalists, the small staff of the Hancock Museum at Newcastle-upon-Tyne has during the past two years accomplished some excellent work. From a 45-ft. Rorqual (*Balaenoptera borealis*) cast ashore near Amble, the complete skeleton, including ear-bones, hyoids, and rudimentary hip-bones, was obtained. The larger bones have been satisfactorily prepared in a sand-pit; but the smaller bones which were macerated as usual in water made so little progress that they have now been transferred to sand. A promising beginning was made with classes from the elementary schools, each of which went through a definite course of six lessons, given by the teachers, who were first rehearsed in the lesson by the curator, Mr. E. L. Gill. Unfortunately this regular system could not be followed in the second year, owing to the overcrowded curriculum of the schools, and the visits are now of small educational value. Perhaps the committee recently appointed by the British Association may devise some scheme that will overcome this difficulty.

The report of the Manchester Museum for the year 1912–13 bears witness to plenty of hard work, but contains nothing of outstanding interest. It is, however, worth reading in order that one may admire the healthy spirit of cooperation as regards museum matters that breathes in Manchester. Representatives of the University, of the City Council, and of subscribers among the outer public, constitute the committe of management. The City Council has increased its grant from 400*l.* to 800*l.* per annum. Professors of the University supervise and aid the museum staff. In the transference of the Egyptian antiquities to the new building, which, with its cases, was provided by Mr. Jesse Haworth, valuable help was given by a number of ladies and gentlemen. Several ladies have maintained a supply of fresh flowers, and at least four other names are mentioned in connection with solid pieces of work of more expert character. To a museum combining so many forces there naturally flow considerable donations, both in money and in kind.

## RADIATION OF GAS MOLECULES EXCITED BY LIGHT.

THE first Guthrie lecture of the Physical Society was delivered on February 27, at the Imperial College of Science, South Kensington, by Prof. R. W. Wood, of Johns Hopkins University, Baltimore. The lecture has been established in memory of Prof. F. Guthrie, who was professor of physics in the Royal College of Science, and was founder of the society, the first meeting having been held in his lecture theatre at the college in 1874. Before Prof. Wood's lecture, Prof. G. Carey Foster gave a short biography of Guthrie, who was born in 1833 and died in 1886, and Sir Oliver Lodge recalled some personal reminiscences of him. Prof. Wood's lecture is summarised in the subjoined abstract, published by the Physical Society.

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The emission and absorption of light by molecules and the allied phenomenon of dispersion have led us to the conception of something within the atom which is capable of responding to light waves in much the same way as a tuning-fork responds to sound waves of the same frequency as its own, and many mathematical treatments have been built up which explain more or less perfectly many of the phenomena in question. These still leave us very much in the dark as to what is going on. Helmholtz explained absorption by introducing a frictional term into his equations of motion for the atom, and though this led at once to an expression which represented anomalous dispersion, it left us ignorant of how the energy absorbed by the molecules was transformed to heat, or how the mean velocity of the molecules was increased by the excitation of vibrations within them. Planck avoided this difficulty by considering that the energy abstracted from the beam of light is re-emitted, though at the time the only experimental evidence was to be found in selective reflection, which occurs only in liquids and solids.

What becomes of the absorbed energy in the case of a gas? This was what he had been asking himself for many years. While he did not require a working model of the atom, he could not, however, be satisfied by an equation in which absorption was represented by a frictional term or selective reflection predicted by the occurrence of an imaginary quantity.

The problem of the constitution of the atom is one which must be approached from many sides, as it is improbable that any single mode of attack will reveal the secret. The spectroscope alone has proved itself powerless, one great difficulty being that in all known methods of exciting spectra one got "the whole or nothing."

Flames, arcs, sparks, and vacuum-tube discharges set a host of vibrations simultaneously in operation within the atom, and resulted in a complex of lines which were difficult to interpret.

His line of attack had been to maintain the molecules in as calm and tranquil a state as possible, by keeping them cool, and then to excite them to radiation by the application of an alternating electromagnetic field of a definite frequency—usually called monochromatic light. That this method has in some degree simplified matters was proved by the fact that sodium vapour could be made to emit only one of the D lines instead of the usual two.

The conditions necessary to stimulate radiation in this way varied considerably with the nature of the element studied. He would begin, however, with the simplest case, that of a vapour which exhibits a single absorption line and emits radiations similar in every respect to the exciting radiations when stimulated by