stalk, whereas a thick prominence in which no differentiation can be made out, lies on the side furthest from the stalk. One must, however, regard its innermost cell layer as belonging to the entoderm, which also is continued into it.

While these changes have been taking place in the embryo, the "breeding-nidus" has increased considerably in size, the uterine epithelium has become thicker, and consists of a finely granular mass of protoplasm in which large round nuclei are found, and often lie in several layers one on top of another; cell boundaries are no longer recognisable, and the pigment granules, which are disappearing, still form a narrow border towards the lumen of the uterus. Before and behind the breeding-nidus is almost altogether closed by great thickenings of the uterine walls. In the region of the breeding-nidus, however, there is a fissure in the connective tissue wall of the uterus which is probably a blood space.

The next stage in the development of the embryo may be shortly characterised as the mushroom form; the embryo becomes more clearly marked off from its stalk, and expands in all directions, but most of all in the direction of the longitudinal axis of the uterus, and now for the first time a bilateral symmetry can with certainty be made out; the whole embryo resembles a mushroom with a thick stalk; the pileus is oval, as seen from above, and is a little broader at one end than at the other, and on the surface, towards the narrower end, is to be seen a shallow depression, which is limited towards the broader end by a slight prominence. This depression corresponds to the spot where the meso- and entoderms have been invaginated. There is as yet no opening to connect the visceral cavity with the outer world. The broader end of the embryo is the head end, the stalk side the back, the surface that projects into the lumen of the uterus the future ventral surface. In this stage a multiple layer of cells has already freed itself from the ectoderm, in front of the place where the invagination took place, and it lies, passing over behind into the undifferentiated cell-mass, between the ecto- and entoderm, but is marked off from both of them by a distinct boundary.

Now while the embryo increases in length, more and more cells press in from the ectoderm at the spot that has been indicated, and specialise themselves towards the front into a real mesoderm, which, however, at first, and for a long time afterwards, occupies only the ventral aspect and also the lateral regions between ectoderm and entoderm, where it of course multiplies independently.

In the meanwhile the thickening of the uterine epithelium has gone on; it now forms a ring, which surrounds three-quarters of the circumference of the breeding-nidus, and which as a broad zone divides the breeding-nidus into two halves, where, by the way, the epithelium has been thickened to a considerable though a less degree; the pigment granules have now disappeared, the placenta has become very large, and the amnion, which has attained a high degree of development, and which consists of numerous large cells with large nuclei, lies closely applied to the uterine epithelium.

It is only when the embryo has still further increased in length, the part posterior to the stalk increasing very quickly in size, that the anus and mouth are formed, but not from a common opening, the blastopore of Balfour. The anus develops as a small fissure in the median line upon the prominence in front of the spot where the invagination has taken place; but the mouth develops far further forwards as an invagination of the ectoderm, consisting of only very few cells. This invagination has an inclination obliquely from behind forwards as it proceeds, and reaches the intestine, dividing its epithelium at the point of junction. This mouth invagination has as yet no lumen; this makes its appearance later, when the embryo already shows its segmentation plainly.

The first trace of this segmentation is the appearance of a cavity on each side in the oldest portions of the mesoderm, *i.e.* in the anterior extremity of the embryo, which splits the mesoderm plates into an inner membrane adjoining the intestine, and an outer one adjoining the ectoderm. These, however, are still connected to each other dorsally and ventrally. Soon afterwards a second pair of similar cavities develops behind, and so on from before backwards. These cavities that appear in segments, and which in their appearance closely resemble the original segmental formation of a vertebrate animal, are the first rudiments of the body cavity. The different structures that develop out of its walls cannot be made out till later. With the exception of the further growth of the posterior end of the embryo, which soon curves itself, rolls itself up spirally, and finally forms manifold loops, and of the progress of the segmentation, and of the corresponding formation of cavities in the mesoderm, no changes take place in the interior of the embryo. Embryos of *P. Edwardsii* of 1–1·5 mm. length always present the same appearance on cross-section: an ectoderm slightly thickened on the ventral aspect, an extraordinarily thin entoderm, and between them on each side a pocket of mesoderm, whose walls touch each other in the ventral median line, and which in well-preserved embryos always are closely applied to the ectoderm, as well as to the entoderm, but which always present a sharply-defined boundary line. The anus is still nothing more than a narrow longitudinal fissure; the mouth has at last opened. Behind the anus is situated the depression, with the place where invagination has taken place.

Externally, on the other hand, a distinct segmentation of the body has taken place corresponding to the cavities in the mesoderm; the anterior segment (head segment) exceeds all the others in size; it consists of two symmetrical, spherical halves, to which the other segments are connected posteriorly; the ventral aspect of the head segment contains the mouth opening. I remark here that the mouth and anal opening that have been mentioned must be regarded as primary in Peripatus; the latter closes at a later stage to make room for a later-developing structure, and the former is thrust in further by a new invagination of the ectoderm, and becomes converted into the œsophageal opening of the intestine. (These two observations require to be checked, and I shall have to do so by examining other embryos.) Each segment carries on each side a prominence which is the rudiment of the limbs that are developed later. The first pair of limbs is surrounded by a number of secondary papillæ, and is drawn into a wide mouth cavity to be utilised as a jaw; the second pair gives the papillæ on whose apices the large slime glands afterwards have their orifices. The tentacles are simply dorsal continuations or prolongations of both head cavities. Now at last, after the embryo has attained its full complement of segments, the first appearance of the nervous system can be made out as a paired ventral thickening of the ectoderm, which, soon separating itself from the ectoderm, extends in two separate threads from one end of the body to the other, only united by the brain, which has been developed in a similar manner in the head. The embryo itself, until it develops a definite gullet, is intimately connected by its ectoderm, by means of the placenta with the maternal organism, and receives its nutriment through its dorsal stalk, which can be quite properly characterised as a navel-string, and which belongs to the first body segment. As soon, however, as it can swallow by help of its gullet, this connection is loosened, and the embryo now eats the food that is provided by the extraordinarily thickened uterine epithelium, which is rich in protoplasmic materials. At any rate, from that time forward coagulated protoplasm is always to be found in the intestine of the embryo, which was previously always empty.

This is, in a few words, an abstract of the most important results of my investigations up to date, which have been made upon something like a hundred young embryos. I here abstain for the sake of brevity from all discussion, but must, however, call attention to the fact how little Balfour's illustrations and the descriptions of the editors agree with the facts as they are here given. I hope it will not be long before I shall be able to lay before my fellow-workers my investigations, which I hope soon to complete, of these interesting and exceedingly anomalous phenomena of embryonic development, accompanied by numerous illustrations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—By a mistake last week the stipend of the Professorship of Botany was given as 500*l.* instead of 700*l.* with a residence rent free. An election will take place in the course of Hilary term. The duty of the professor is to lecture and give instruction in botany. He will also have charge and supervision of the Botanical Garden and of the botanical collections belonging to the University; and it will be part of his duty to make such gardens and collections accessible to and available for the instruction of students attending his lectures. Candidates are requested to send to the

Registrar of the University their application, and also any documents which they may wish to submit to the electors, on or before Saturday, January 26, 1884.

The Professorship of Rural Economy—now separated from that of Botany—will be filled up in December. Candidates are requested to send to the Registrar of the University their applications, and any documents they may wish to submit to the electors, on or before Monday, December 10, 1883. According to the regulations sanctioned by the Court of Chancery, the Sibthorpian Professor of Rural Economy shall lecture and give instruction on the scientific principles of agriculture and forestry. He shall be entitled to the emolument of 200*l.* derived from the benefaction of Dr. John Sibthorp, Doctor of Medicine, and assigned to the professorship. The professor holds his office for a period of three years from election, and no longer. He may be re-elected for a second period of three years, and no longer; but no professor shall hold the professorship for more than six years consecutively. The professor will have the use of the garden appropriated for making experiments on the subjects of his professorship. The professor shall give not less than twelve lectures in the course of the academical year, in full term, and not more than two in any one week.

CAMBRIDGE.—The following are the speeches made to the Senate of the University by the Public Orator (Mr. J. E. Sandys) in presenting Professors Foster and Macalister for the complete degree of M.A. *honoris causâ*, on November 8:—

"Dignissime domine, domine procancellarie et tota Academia: In hoc ipso loco, duodecim abhinc annos, unum e Collegii maximi Prælectoribus auspiciis optimis titulo vestro honorifico exornastis. Hodie eundem, tot annorum usu et experientia spectatum probatumque, et Academiæ totius Professoribus merito adscriptum, senatus nostri in ordinem honoris causa adsciscimus. Quantum interim, hujus præsertim laboribus, inter alumnos nostros creverit vigueritque physiologiæ studium, vosmet ipsi omnes animo grato recordamini. Ut animantium in corporibus ex ipso corde, velut e fonte quodam, salutares illi sanguinis rivi per membra omnia fluunt refluuntque; non aliter corporis Academici in partes quam plurimas ex hoc fonte scientiæ flumina effluxisse atque inde rursus redundasse dixerim. Tali e fonte quot alumnis vires novæ redditæ sunt: quotiens ex alumnis rivuli fontem ipsum denuo auxerunt! E discipulis vero tam multis cum magistro tanto feliciter consociatis, plurimos adhuc superesse, nonnullos etiam adesse hodie gaudemus; unum illum non sine lacrimis desideramus qui nascentis vitæ primordiis hujus auxilio sagacissime investigatis, nuper inter Alpium culmina, in ipso ætatis flore, morte immatura e nobis est abreptus. Talium filiorum progenies Matri Almæ indies nova succrescat: magistrorum talium accesionibus et Professorem et Senatorum ordo identidem nobis augeatur!

"Vobis præsento Collegii sacrosanctæ Trinitatis socium, Physiologiæ Professorem illustrem, MICHAELEM FOSTER."

"In Professoribus novis vestro omnium nomine salutandis, fato quodam iniquo successoris laudes decessoris desideria nonnunquam aliquatenus imminui videntur. Hodie vero ornat adhuc Professorum ordinem eloquentissimus ille Anatomiæ Professor quem diu sumus admirati. Integro igitur sinceroque gaudio Professorem illum salvere jubemus, quem Caledonia Hiberniæ quondam donavit, Hibernia Britanniæ nuper reddidit. Salutamus virum qui corporis humani scientiam interiorem, antiquissimum illud atque regium (ut nuper audivimus) scribendi argumentum, quasi propriam provinciam penitus exploravit; qui ne his quidem finibus contentus, sed etiam in alias rerum naturæ regiones egressus, non modo de zoologia et de comparativa quæ dicitur anatomia egregie meritus est, sed geologiæ quoque operam singularem impendit, petrographiæ præsertim recentiores, progressus curiositate minuta perscrutatus. Idem et litterarum amore et linguarum peritia insignis, inter rerum antiquarum monumenta ne hieroglyphica neglexit, neque historiam ecclesiasticam intactam reliquit. Ergo non uni tantum Collegio sed toti Academiæ gratum est, virum tot tantisque animi dotibus instructum, societati illi tam cito esse adscriptum, cui medicinæ studia commendavit olim vir et de litteris antiquis et de scientiis recentioribus præclare meritus, Thomas Linacre.

"Vobis præsento Collegii Divi Johannis socium, Anatomiæ Professorem insignem, ALEXANDRUM MACALISTER."

The allusions to the growth of the physiological school, to the loss of Prof. F. M. Balfour, to Prof. Macalister's inaugural lecture with its happy antiquarian illustrations, and his speedy enrolment as a Fellow of St. John's, were heartily taken up by the members of the Senate and the undergraduates present.

The Special Board for Medicine publish for the guidance of students proceeding to medical and surgical degrees the following schedule defining the range of the examination in elementary biology under the regulations which come into effect on the first day of January, 1884 (Grace, November 15, 1883). The examination in elementary biology will have reference to (1) the fundamental facts and laws of the morphology, histology, physiology, and life-history of plants as illustrated by the following types: *Saccharomyces*, *Protococcus*, *Mucor*, *Spirogyra*, *Chara* or *Nitella*, a fern, *Pinus*, and an angiospermous flowering plant; (2) the fundamental facts and laws of animal morphology, as illustrated by the following types: *Amœba*, *Paramœcium* or *Vorticella*, *Hydra*, *Lumbricus*, *Astacus*, *Anodon*, *Amphioxus*, *Scyllium*, *Rana*, *Lepus*. Under the head of vegetable physiology the student will not be expected to deal with special questions relating to the more highly differentiated flowering plants. He will be expected to show a practical knowledge of the general structure of each of the animal types above specified, and an elementary knowledge of the chief biological laws which the structural phenomena illustrate. He will also be expected to show an elementary knowledge of the general developmental history of *Amphioxus* and of *Rana*. He will not be expected to deal with purely physiological details.

The subject announced for the next Adams Prize to be adjudged in 1885, is as follows: Investigate the laws governing the interaction of cyclones and anticyclones on the earth's surface. In order to give precision to this, the following suggestions are given to the examiners:—An infinite plane has surface density $\frac{g}{2\pi}$ (where g is gravity); on one side of it is air in equilibrium, the density of which must diminish according to the barometric law as we recede from the plane. The system revolves as a rigid body, about an axis perpendicular to the plane, with a constant angular velocity ω. If one or more vortices, with a revolution either consentaneous with ω (cyclones), or adverse thereto (anticyclones), be established in the air, investigate their motions. It may be well to consider the axes of the vortices as either straight or curved, and perpendicular or inclined to the plane. If possible, pass to the case in which the vortices exist in the atmosphere surrounding a rotating globe.

The Rev. H. W. Watson has been approved for the degree of Sc.D.—Prof. Darwin is arranging to give a course of practical teaching in astronomy with the instruments under his charge. Next term Mr. H. H. Turner of Trinity College will undertake this course.—The General Board of Studies, in reissuing its recommendations as to Readers, Demonstrators, &c., has asked that power be given to the Museums and Lecture Rooms Syndicate to obtain plans for a foundry for the Department of Mechanism, for buildings for Botany, and for additional buildings for Comparative Anatomy and Physiology.—It is recommended that a Curator of the Museum of General and Local Archæology be appointed, at a salary of 100*l.* per annum.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, vol. cxvi. No. 694, October, 1883.—The commercial and dynamic efficiencies of steam-engines, by Prof. R. H. Thurston. In this paper there are calculated the ratio of expansion to furnish power most economically, the maximum efficiency of a given plant, and maximum efficiency of fluid, when such data are taken into account, as total annual cost of steam, and total annual cost of all items variable with size of steam-cylinder.—Mr. R. Grimshaw, in a paper on the steam-engine indicator as a detector of lost motion, describes the use of the indicator to pick out defective setting of cranks, cross-heads, &c.—The next three articles are on the water supply of cities in ancient times, on oil-dressed belting, and a report on the pressure-governed gas-meter and burner.—The address by Prof. Rowland, entitled "A Plea for Pure Science," lately reprinted in NATURE, is also reproduced *in extenso*.

Annalen der Physik und Chemie, xxii. No. 10, contains a long memoir by Professors Sohncke and Wangerin on interference phenomena obtained with thin and especially with wedge-shaped laminæ. The article will be continued in the next number.—On the changes of volume of metals and alloys on melting, by Prof. Eilhard Wiedemann. The metals were cast in thin rods, then dropped into a nearly-fitting glass tube,