in which the fœtus is kept during the whole time of utero-gestation, and upon the influence of the bodily and mental affections of the mother upon the child; in further illustration of which, several instances are detailed in proof of the descent of various peculiarities of the mother to the offspring.

Observations on the Changes the Ovum of the Frog undergoes during the Formation of the Tadpole. By Sir Everard Home, *Bart. V.P.R.S.* Read November 25, 1824. [*Phil. Trans.* 1825, *p.* 81.]

The ova of the Frog, when examined in the ovaria, consist of dark coloured vesicles, which acquire a gelatinous covering on entering the oviduct, and are completely formed by the time they reach the cavities in which the oviducts terminate, and during their expulsion from which they receive the male influence; after this, the contents of the ovum, previously fluid, coagulate and expand, the central part being converted into brain and spinal marrow, while in the darker substance of the egg the heart and other viscera are formed. The membrane forming the vesicles being destined to contain the embryo when it has become a tadpole, enlarges as the embryo increases, and may be said to perform the office both of the shell and its lining membrane in the pullet's egg, serving as defence and allowing aëration. The black matter which lines the vesicle probably tends to the defence of the young animals from the too powerful influence of the solar rays, frogs' spawn being generally deposited in exposed situations. Sir Everard observes, that in the aquatic Salamander, an animal whose mode of breeding closely resembles the frog, this nigrum pigmentum is wanting; but that that animal deposits its eggs within the twisted leaves of water plants, which afford them an equivalent protection.

A general Method of calculating the Angles made by any Planes of Crystals, and the Laws according to which they are formed. By the Rev. W. Whewell, *F.R.S. Fellow of Trinity College, Cambridge.* Read November 25, 1824. [*Phil. Trans.* 1825, *p.* 87.]

The author, after stating the inconsistencies, inelegancies, and imperfections of the received notation for expressing the planes of a crystal, and the laws of decrement by which they arise, and of the usual methods of calculating their angles, explains the object of the present paper, which is to propose a system exempt from these inconveniencies, and adapted to reduce the mathematical portion of crystallography to a small number of simple formulæ, of universal application. According to the method here followed, each plane of a crystal is represented by a symbol indicative of the laws from which it results, which, by varying only its indices, may be made to represent any law whatever; and by means of these indices, and of the primary angles of the substance, we may derive a general formula expressing the dihedral angle contained between *any one plane* re-

sulting from crystalline laws, and *any other*. In the same manner we can find the angle contained between any two edges of the derived crystal. Conversely, having given the plane, or dihedral angles of any crystal, and its primary form, we can, by a direct and general process, deduce the laws of decrement according to which it is constituted.

The purely mathematical part of this paper depends on two formulæ, demonstrated by the author elsewhere and here assumed as known; by means of one of which the dihedral angle included between any two planes can be calculated, when the equations of both planes are given; and by the other, the plane angle included between any two given right lines can in like manner be expressed by assigned functions of the coefficients of their equations, supposed given. These formulæ being taken for granted, nothing remains but to express by algebraical equations the planes which result from any assigned laws of decrement, for the different primitive forms which occur in crystallography.

To this effect, the author assumes one of the angles of the primitive form, supposed, in the first case, a rhomboid, as the origin of three coordinates, respectively parallel to its edges, and supposes any secondary face to arise from a decrement on this angle, by the subtraction of any number of molecules on each of the three edges. It is demonstrated first, that the equation of the plane arising from this decrement will be such, that the coefficients of the three coordinates in it (when reduced to its simplest form,) will be the reciprocals of the number of molecules subtracted on the edges to which they correspond. If the constant part of this equation be zero, the face will pass through the origin of the coordinates; if not, a face parallel to it may be conceived passing through such origin, and will have the same angles of incidence, &c. on all the other faces of the crystal; so that all our reasonings may be confined to planes passing through the origin of the coordinates.

To represent any face, the author incloses between parentheses the reciprocal co-efficients of the three coordinates of its equation, or rather of the numbers of molecules subtracted on each of the three edges to form it, with semicolons between: this he calls the symbol of that face. He then shows how truncations on all the different edges and angles of the primitive form are represented in this notation, by one or more of the elements of which the symbol consists becoming zero or negative, thus comprehending all cases which can occur in one uniform analysis.

The law of symmetry in crystallography requires that similar angles and edges of the primitive form should be modified similarly to form a perfect secondary crystal. This gives rise to *co-existent planes*. In the rhomboid, these co-existent planes are found by simple permutation of the elements of the symbol one among another. In the prism, such only must be permuted as relate to similar edges. In other primitive forms, as for example in the tetrahedron, the author institutes a particular inquiry into the decrements of co-existent

planes, which truncate the different angles of the primitive form, as referred to that particular angle which he assumes as the origin of the coordinates. It follows from this example, that in this latter case each of the elements of the symbol must be combined with its excess over each of the remaining two, to form a new symbol. This gives four symbols (including the original one), each susceptible of six permutations, making in all 24 faces.

The author then proceeds to consider the cases of the irregular tetrahedron and octohedron, the triangular prism, and rhomb dodecahedron, investigating in each case the symbols of the co-existent planes, and illustrating his theory with examples taken from the crystalline forms of zircon, sulphur, and other minerals. He next treats of the order in which the faces lie in a perfect crystal, and the determination of such faces as are adjacent or otherwise. To this end, he conceives an ellipsoid inscribed within the crystal, having for its three axes the three most remarkable lines in the primitive form, and by means of the well-known equation of the second degree representing such an ellipsoid, combined with the equation of any proposed, he deduces the longitude and latitude, on the surface of the ellipsoid, of the point at which it would be touched by a plane parallel to such face. The results are included in general and explicit formulæ, by whose application, in any proposed case, the sequence and arrangement of the faces in the perfect crystal are readily discovered.

The angles made by edges of the secondary form are next investigated; after which the author, having recapitulated his results, takes occasion to refer to a paper by Mr. Levy, who had previously, but unknown to Mr. Whewell, employed the representation of a secondary plane, by its equation referred to the three principal edges of the primitive form, but only in a particular case; whereas the investigation and notation in the present paper are absolutely general.

In the course of this paper, Mr. Whewell instances the application of his analysis to the solution of the following problems:—

Knowing the dihedral angles of the secondary rhomboid, to find the symbol of its faces, or their laws of decrement.

To find what laws of decrement give a secondary rhomboid similar to the primary one.

Knowing the lateral angles made by the planes of any bipyramidal dodecahedron, to find the symbols.

Knowing the angles made by any plane, with two primary planes to find its symbol.

To find what laws give prisms parallel to the axis of the rhomboid.

To find the symbol of a plane which truncates the edge of any secondary rhomboid.