balance, ovulation occurs and then the *LH* causes formation of the corpus luteum, the yellow body which fills up the place formerly occupied by the ovum before it was extruded by the erupting follicle.

A number of recent researches have cast doubt on the existence of these two separate gonadotropic hormones of the pituitary, and suggest that the different types of response in the test animals may be due to the differing rate of absorption of the hormone.

The maintenance of the gonads is complicated even if it is effected only by a single gonadotropic hormone and if only one sex and one species of animal is considered. If it is due to two hormones the situation becomes very much more complex. Although some thirteen years have elapsed since the subject began to be intensively studied, nevertheless it appears that little more than a start has been made in securing an understanding of the many factors involved.

EXACT SCIENCE IN ANTIQUITY*

CONTACT between highly different cultures apparently gave the impetus to important developments in the early history of the exact sciences, namely, mathematics and astronomy. The development of exact science cannot be adequately described as a systematic step-by-step progress. In any event where we are able to disclose the conditions of essential new development, the contact between highly different cultures appears to give the initial impetus. On the other hand, 'culture' is in itself equivalent to tradition, which unifies large groups of populations into a common type of opinion and action. However, the same force, tradition, which defines a culture as an individual being, becomes an increasing impediment to further independent development and creates the long periods of 'dark ages', which cover by far the largest part of human history.

The mathematical texts of the First Babylonian Dynasty, that of King Hammurabi (about 1800 B.C.) treated elementary geometrical problems in a very algebraic form. This rise of the abstract representation in mathematics may be attributed to a historical event, the complete replacement of the Sumerians by the Semitic population.

The Semites, coming into the land of the Sumerians, began to write their own Semitic language with the Sumerian picture script. The Sumerians used a single sign for a single concept (ideograms). The Semites took the signs and used them in two different ways : first, in their old sense as representations of single concepts, and secondly, as pure sound symbols (syllables) for composing their own words phonetically.

Using the symbol to represent a single concept corresponds in the field of mathematics exactly to our algebraic notations. Instead of writing 'length' with six letters, for example, it was sufficient to write a single letter 'L', or instead of writing out 'plus' or 'addition', it was sufficient to use one single sign $+$.

Evidently the idea of this algebraic form of mathematics occurred to the Semites when they saw the single symbol or ideogram form of writing alongside their own phonetic system. We see here again how an entirely unconscious external influence caused the second fundamental invention of 'Babylonian mathematics', the 'algebraic' notation. Without such a deep linguistic difference such a powerful instrument as ideographic notation for mathematical operations would never have been introduced, as the parallel with Egypt clearly shows.

An atmosphere of general learning conducive to improvement along many lines of scholarship and science was created by the necessity of translating

the language of the original occupants of this section of Mesopotamia to that of the new rulers. Systematic philological schools were created, and their existence is recorded by the large collections of word lists, grammatical rules, etc., used in the translation of Sumerian to Semitic.

Later in the history of Babylon, when it was conquered by the Assyrians, who constructed a powerful kingdom reaching from Persia to Egypt, politically powerless Babylon became an admired cultural centre of a world-wide empire, comparable to the position of Rome in medieval times. Persian priests, Jews, and Greeks lived in Babylon, and used Aramaic as an international language. There arose competition between the national cultures, for example, Zarathustra, Abraham and Pythagoras were each proclaimed as the inventor of all science and creator of astronomy, astrology, and number-wisdom, and each group asserted itself to be the oldest and consequently the teacher of mankind. This atmosphere of intellectual competition stimulated further development of Babylonian astronomy. This new astronomy was based not on old observation of miraculous exactitude, as usually pretended, but, on the contrary it reduced the empirical dates to the utmost minimum, mainly period relations, which are easy to observe and almost unaffected by the inexactitude of single instrumental observations.

Ptolemy (100–180 B.C.) was one of the greatest scholars of all times. High tribute should be paid to the supreme mastership and independent judgment exhibited in Ptolemy's "Almagest" on mathematical astronomy, his "Tetrabiblos" on astrology, and his "Geography".

The main school of geographers, however, did not follow Ptolemy, but preferred general descriptions of different regions and their population to the more fundamental problem of exact mapping, which involved astronomical observations for determination of geographical position. This tendency toward popular representation was one of the main reasons for the rapid decline of ancient exact science, and it finally created the race of commentators, who killed any kind of independent thinking with their tedious explanations of every little step.

The sexagesimal system of the Sumerians, in which the unit represented powers of 60, such as 60 itself, 3,600 or 1/60 is worthy of note. (We have a remnant or suggestion of the sexagesimal system in our clock dial of 60 seconds to the minute and 60 minutes to the hour.)

The Sumerians at first represented the units of different powers to 60 by a difference in size of the symbol, but later this careful notation was omitted, and 'place value' notation was initiated, the ancestor of our present decimal number system.

* Substance of a paper read by Dr. Otto Neugebauer at the Bicentennial Conference of the University of Pennsylvania on September 17.