Introduction to Human Development

Human development begins at fertilization when an oocyte (ovum) from a female is fertilized by a sperm (spermatozoon) from a male and becomes a single-celled zygote. Development involves many changes that transform the zygote into a multicellular human being. Embryology is concerned with the origin and development of a human being from a zygote to birth. The stages of development before birth are shown in Fig. 1.1.

**IMPORTANCE OF AND ADVANCES IN EMBRYOLOGY**

The study of prenatal stages and mechanisms of human development helps us understand the normal relationships of adult body structures and the causes of birth defects (congenital anomalies). Much of the modern practice of obstetrics involves applied or clinical embryology. Because some children have birth defects, such as spina bifida or congenital heart disease, the significance of embryology is readily apparent to pediatricians. Advances in surgery, especially in procedures involving the prenatal and pediatric age groups, have made knowledge of human development more clinically significant. In addition, as we discover new information about the development processes, we in turn have a better understanding of many diseases and their process, as well as their treatment.

Rapid advances in molecular biology have led to the use of sophisticated techniques (e.g., genomic technology, chimeric models, transgenics, and stem cell manipulation) in research laboratories to explore such diverse issues as the genetic regulation of morphogenesis, the temporal and regional expression of specific genes, and the mechanisms by which cells are committed or differentiate to form the various parts of the embryo. Researchers continue to learn how, when, and where selected genes are activated and expressed in the embryo during normal and abnormal development.

Development begins at fertilization (see Fig. 1.1, first week). The embryonic period covers the first 8 weeks of development of an embryo. The fetal period begins in the ninth week. Examination of the timetable shows that the most externally visible advances occur during the third to eighth weeks.

The critical role of genes, signaling molecules, receptors, and other molecular factors in regulating early embryonic development is rapidly being delineated. In 1995 Edward B. Lewis, Christiane Nüsslein-Volhard, and Eric F. Wieschaus were awarded the Nobel Prize in Physiology or Medicine for their discovery of genes that control embryonic development. Such discoveries are contributing to a better understanding of the causes of spontaneous abortion and birth defects.

Robert G. Edwards (1925–2013) and Patrick Steptoe (1913–1988) pioneered one of the most revolutionary developments in the history of human reproduction: the technique of in vitro fertilization. Their studies resulted in the birth of Louise Brown, the first “test tube baby,” in 1978. Edwards was awarded the Nobel Prize in 2010.

In 1997 Ian Wilmut and colleagues were the first to produce a mammal (a sheep dubbed Dolly) by cloning using the technique of somatic cell nuclear transfer. Since then, other animals have been cloned successfully from cultured differentiated adult cells. Interest in human cloning has generated considerable debate because of social, ethical, and legal implications. Moreover, there is concern that cloning may result in an increase in the number of neonates (newborns) with birth defects and serious diseases.

**Human embryonic stem cells** are pluripotential and capable of developing into diverse cell types. The isolation and culture of human embryonic and other stem cells may hold great promise for the development of molecular therapies.

**DESCRIPTIVE TERMS**

In anatomy and embryology, specific terms of position, direction, and various planes of the body are used. Descriptions of the adult are based on the anatomical position; the body is erect, the upper limbs are at the sides, and the palms are directed anteriorly (Fig. 1.2A). The descriptive terms of position, direction, and planes used for embryos are shown in Fig. 1.2B to E. In describing development, it is necessary to use words denoting the position of one part relative to another or to the body as a whole. For example, the vertebral column develops in the dorsal part of the embryo and the sternum is in the ventral part of the embryo.
Fig. 1.1 Early stages of human development. An ovarian follicle containing an oocyte, ovulation, and phases of the menstrual cycle are shown.
AGE (weeks)

3
- First missed menstrual period
- Primitive streak

4
- Stage 10 begins
- Heart begins to beat
- Primitive Circulatory System
- Neural folds fusing

5
- Stage 11 begins
- 2 pairs of pharyngeal arches
- Heart bulge
- Nasal pit
- Primordial mouth

6
- Stage 12 begins
- Upper limb bud
- Lower limb bud
- Upper lip and nose formed

7
- Stage 13 begins
- External acoustic meatus
- Ventral view
- CRL: 8.5 mm

8
- Stage 14 begins
- External genitalia have begun to differentiate.
- Large forehead
- Ear
- Wrist
- Knee
- Elbow

9
- Stage 15 begins
- Genital tubercle
- Urethral groove
- Anus
- CRL: 10.5 mm

10
- Stage 16 begins
- Genital tubercle
- Urethral groove
- Anus
- CRL: 12.5 mm

Fig. 1.1, cont'd
Fig. 1.2 Illustrations of descriptive terms of position, direction, and planes of the body. A, Lateral view of an adult in the anatomical position. B, Lateral view of a 5-week embryo. C and D, Ventral views of a 6-week embryo. The median plane is an imaginary vertical plane of section that passes longitudinally through the body, dividing it into right and left halves. A sagittal plane refers to any plane parallel to the median plane. A transverse plane refers to any plane that is at right angles to both the median and frontal planes. E, Lateral view of a 7-week embryo. A frontal (coronal) plane is any vertical plane that intersects the median plane at a right angle and divides the body into front (anterior or ventral) and back (posterior or dorsal) parts.

**CLINICALLY ORIENTED QUESTIONS**

1. Why do we study human embryology? Does it have any practical value in medicine and other health sciences?

2. Physicians date a pregnancy from the first day of the last normal menstrual period, but the embryo does not start to develop until approximately 2 weeks later (see Fig. 1.1). Why do physicians use this method?

The answers to these questions are at the back of this book.
Answers to Chapter 1 Clinically Oriented Questions