美国医师执照考试

High-Yield™ Embryology

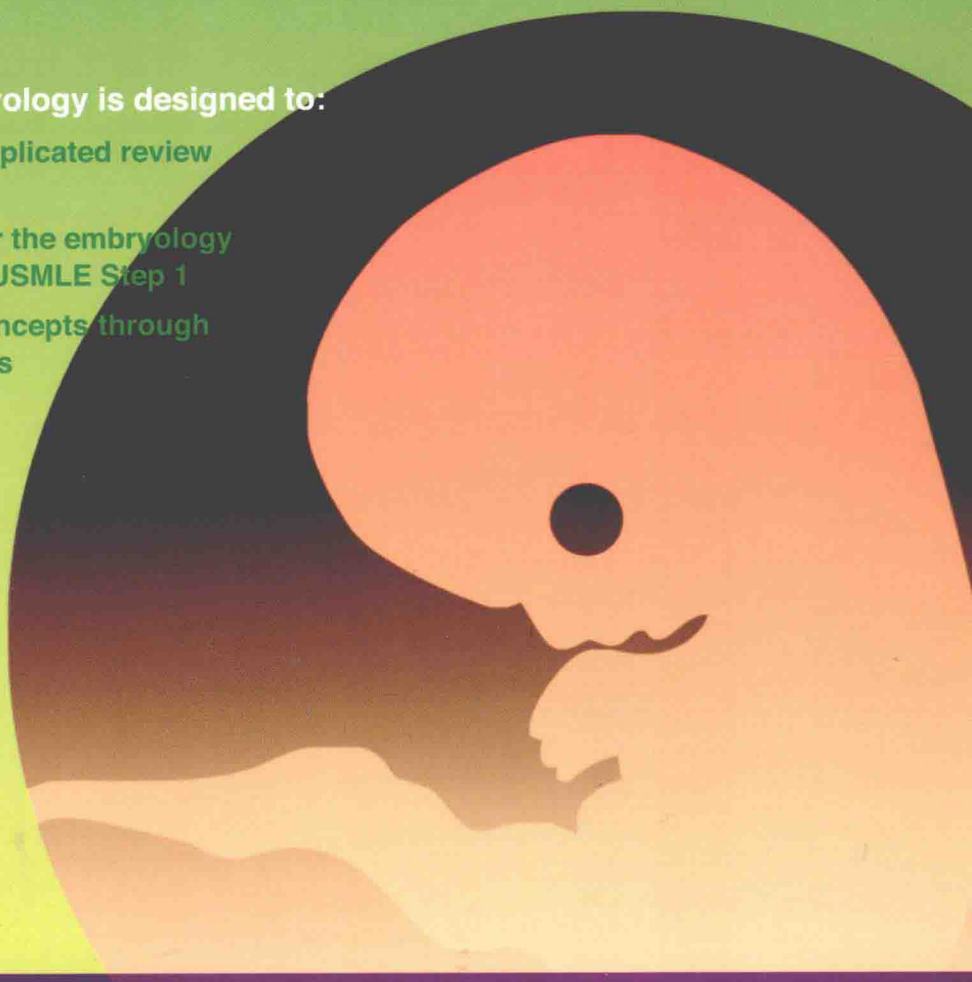
胚胎学

（第4版）

RONALD W. DUDEK

High-Yield™ Embryology is designed to:

- Provide an uncomplicated review of embryology
- Help equip you for the embryology questions on the USMLE Step 1
- Clarify difficult concepts through simple illustrations



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Embryology

（第 4 版）

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图书在版编目（CIP）数据

High-Yied™胚胎学 = High-Yield™ Embryology：第4版：英文/（美）杜德克（Dudek,R,W.）编写。--北京：北京大学医学出版社，2013.1
（美国医师执照考试丛书）
ISBN 978-7-5659-0478-3

Ⅰ.①H… Ⅱ.①杜… Ⅲ.①人体胚胎学-医师-资格考试-美国-自学参考资料-英文 Ⅵ.①R321
中国版本图书馆CIP数据核字(2012)第255517号

北京市版权局著作权合同登记号：01-2012-5815

Ronald W. Dudek: Embryology 4th ed
ISBN: 978-1-60547-316-1

美国医师执照考试：High-Yield™ 胚胎学（第4版）

编　　写：Ronald W. Dudek
出版发行：北京大学医学出版社(电话：010-82802230)
地　　址：(100191)北京市海淀区学院路38号 北京大学医学部院内
网　　址：http://www.pumpress.com.cn
E-mail：booksale@bjmu.edu.cn
印　　刷：北京京华虎彩印刷有限公司
经　　销：新华书店
责任编辑：冯智勇　　**责任印制**：张京生
开　　本：787×1092mm　1/16　**印张**：10.75　**字数**：265千字
版　　次：2013年1月第4版　　2013年1月第1次印刷
书　　号：ISBN 978-7-5659-0478-3
定　　价：46.00元

出版说明

High-Yield™ 系列丛书是针对美国医师执照考试（United States Medical Licensing Examination, USMLE）的知名品牌图书，受到世界各地读者的欢迎。该系列丛书具有以下特色：

1. 内容高度概括，重点突出，有利于读者快速掌握学科的核心知识。
2. 编排新颖，既有基础知识要点的介绍，又有以疾病为核心的综合归纳，并体现了相关学科的横向联系。
3. 语言规范、地道，既有利于读者快速掌握专业词汇，又有利于医学英语思维的培养。

本系列丛书是参加美国医师执照考试的必备辅导用书，也可作为我国医学院校从事双语教学的教材和参考用书，对教师进行英语授课，学生学习、参加考试具有重要的参考价值。

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I would like to dedicate this book to
my father, Stanley J. Dudek, who died
Sunday, March 20, 1988, at 11 A.M.
It was his hard work and sacrifice
that allowed me access to the finest
educational institutions in the country
(St. John's University in Collegeville, MN;
the University of Minnesota Medical School;
Northwestern University; and the University
of Chicago). It was by hard work and
sacrifice that he showed his love for his wife,
Lottie; daughter, Christine; and grandchildren,
Karolyn, Katie, and Jeannie.
I remember my father often as a good man
who did the best he could.
Who could ask for more?
My father is missed and remembered by many.

Preface

The fourth edition of *High-Yield™ Embryology* marks a milestone for this book. Over the years, my didactic and organizational efforts in the first three editions have been supplemented by the suggestions and comments from the many medical students who have used this book in preparation for the USMLE Step 1. As you may know, I include my e-mail address in the prefaces of all my books and ask for feedback from my readers. I pay close attention to these suggestions, and most have been included in this edition.

I have retained the clinical vignettes, which first appeared in the third edition. All these cases were written by Shawn McGill, a medical student at the Brody School of Medicine. He did a wonderful job with these, including quotations from the patients or the patients' parents of the sort that you will often hear in the clinic.

In the fourth edition, clinical images are now shown next to their descriptions in an accessible new layout for more efficient study. This edition is thus beautifully concise and filled with high-yield information. What more could one want?

I would appreciate receiving your comments or suggestions concerning *High-Yield™ Embryology*, Fourth Edition, especially after you have taken USMLE Step 1. Your suggestions will find their way into the fifth edition. You may contact me at dudekr@ecu.edu.

Contents

Chapter 1

Prefertilization Events

I Gametes (Oocytes and Spermatozoa)

A. Are descendants of **primordial germ cells** that originate in the wall of the yolk sac of the embryo and migrate into the gonad region.

B. Are produced in the adult by either **oogenesis** or **spermatogenesis**, processes that involve **meiosis**.

II Meiosis

A. Occurs **only during the production of gametes**.

B. Consists of two cell divisions (**meiosis I and meiosis II**) and results in the formation of gametes containing 23 chromosomes and 1N amount of DNA (23,1N).

C. Promotes the exchange of small amounts of maternal and paternal DNA via **crossover** during meiosis I.

III Female Gametogenesis (Oogenesis) (Figure 1-1)

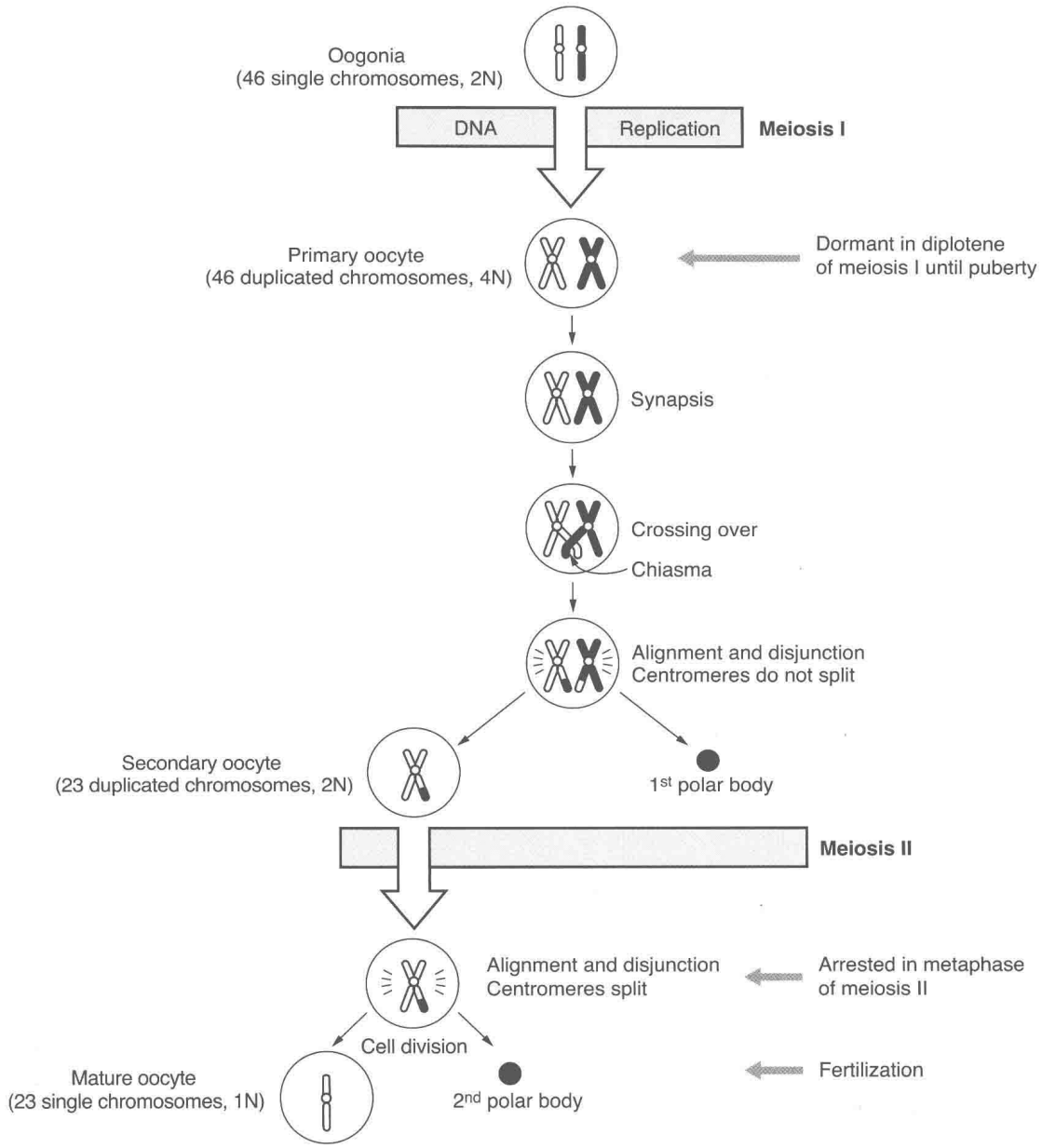
A. **PRIMORDIAL GERM CELLS (46,2N)** from the wall of the yolk sac arrive in the ovary at week 4 of embryonic development and differentiate into **oogonia** (46,2N).

B. Oogonia enter **meiosis I** and undergo DNA replication to form **primary oocytes** (46,4N). All primary oocytes are formed by the **fifth month of fetal life** and remain dormant in **prophase (diplotene) of meiosis I until puberty**.

C. During a woman's ovarian cycle, a primary oocyte completes meiosis I to form a **secondary oocyte** (23,2N) and a **first polar body**, which probably degenerates.

D. The secondary oocyte enters **meiosis II**, and ovulation occurs when the chromosomes align at metaphase. The secondary oocyte remains **arrested in metaphase of meiosis II** until fertilization occurs.

E. At fertilization, the secondary oocyte completes meiosis II to form a **mature oocyte** (23,1N) and a **second polar body**.



● **Figure 1-1 Female gametogenesis (oogenesis).** Note that only one pair of homologous chromosomes is shown (white = maternal origin; black = paternal origin). Synapsis is the process of pairing of homologous chromosomes. The point at which the DNA molecule crosses over is called the chiasma and is where exchange of small amounts of maternal and paternal DNA occurs. Note that synapsis and crossing over occur only during meiosis I.

IV Hormonal Control of the Female Reproductive Cycle (Figure 1-2)

A. The hypothalamus secretes **gonadotropin-releasing hormone** (GnRH).

B. In response to GnRH, the adenohypophysis secretes the gonadotropins, **follicle-stimulating hormone** (FSH) and **leuteinizing hormone** (LH).

C. FSH stimulates the development of a secondary follicle to a Graafian follicle within the ovary.

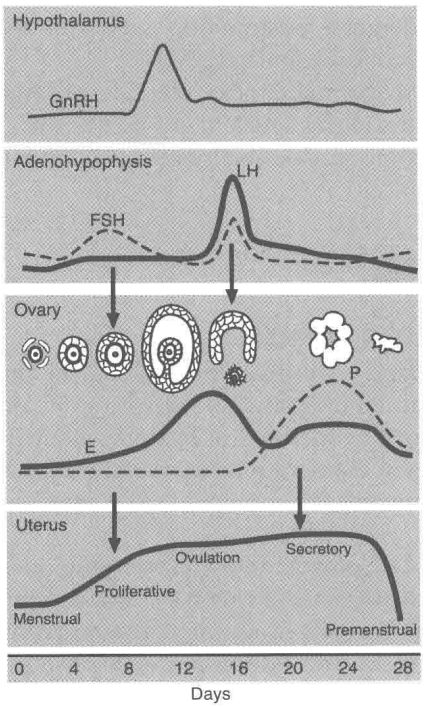
D. Granulosa cells of the secondary and Graafian follicle secrete **estrogen**.

E. Estrogen stimulates the endometrium of the uterus to enter the proliferative phase.

F. LH stimulates ovulation.

G. Following ovulation, granulosa lutein cells of the corpus luteum secrete **progesterone**.

H. Progesterone stimulates the endometrium of the uterus to enter the secretory phase.



● **Figure 1-2 Hormonal control of the female reproductive cycle.** The various patterns of hormone secretion from the hypothalamus, adenohypophysis, and ovary are shown. These hormones prepare the endometrium of the uterus for implantation of a conceptus. The menstrual cycle of the uterus includes the following: (1) The menstrual phase (days 1–4), which is characterized by the **necrosis and shedding** of the functional layer of the endometrium. (2) The proliferative phase (days 4–15), which is characterized by the **regeneration** of the functional layer of the endometrium and a **low basal body temperature** (97.5°F). (3) The ovulatory phase (14–16), which is characterized by **ovulation** of a secondary oocyte and coincides with the leuteinizing hormone (LH) surge. (4) The secretory phase (days 15–25), which is characterized by **secretory activity** of the endometrial glands and an **elevated basal body temperature** (>98°F). Implantation of a conceptus occurs in this phase. (5) Premenstrual phase (days 25–28), which is characterized by **ischemia** due to reduced blood flow to the endometrium. E = estrogen; FSH = follicle-stimulating hormone; GnRH = gonadotropin-releasing hormone; LH = leuteinizing hormone; P = progesterone.

V Male Gametogenesis (Spermatogenesis) (Figure 1-3)

is classically divided into three phases: spermatocytogenesis, meiosis, and spermiogenesis.

A. SPERMATOCYTOGENESIS

1. **Primordial germ cells (46,2N)** from the wall of the yolk sac arrive in the testes at week 4 of embryonic development and remain dormant until puberty.
2. At puberty, primordial germ cells differentiate into **type A spermatogonia** (46,2N).
3. Type A spermatogonia undergo **mitosis** to provide a continuous supply of stem cells throughout the reproductive life of the male (called spermatocytogenesis).
4. Some type A spermatogonia differentiate into **type B spermatogonia** (46,2N).

B. MEIOSIS

1. Type B spermatogonia enter meiosis I and undergo DNA replication to form **primary spermatocytes** (46,4N).
2. Primary spermatocytes complete meiosis I to form two **secondary spermatocytes** (23,2N).
3. Secondary spermatocytes complete meiosis II to form four **spermatids** (23,1N).

C. SPERMIOGENESIS

1. Spermatids undergo a **postmeiotic series of morphological changes** (called spermiogenesis) to form **sperm** (23,1N).
2. Newly ejaculated sperm are incapable of fertilization until they undergo **capacitation**, which occurs in the female reproductive tract and involves the unmasking of sperm glycosyltransferases and removal of proteins coating the surface of the sperm.

VI Clinical Considerations

A. OFFSPRING OF OLDER WOMEN

1. Prolonged dormancy of primary oocytes may be the reason for the high incidence of chromosomal abnormalities in offspring of older women. Since all primary oocytes are formed by month 5 of fetal life, a female infant is born with her entire supply of gametes. Primary oocytes remain dormant until ovulation; those ovulated late in the woman's reproductive life may have been dormant for as long as 40 years.
2. The incidence of **trisomy 21 (Down syndrome)** increases with advanced age of the mother. The primary cause of Down syndrome is maternal meiotic nondisjunction. Clinical findings include severe mental retardation, epicanthal folds, Brushfield spots, simian creases, and association with a decrease in α-fetoprotein.

B. OFFSPRING OF OLDER MEN An increased incidence of **achondroplasia** (an autosomal dominant congenital skeletal anomaly characterized by retarded bone growth in the limbs with normal-sized head and trunk) and **Marfan syndrome** are associated with advanced paternal age.