Learning Objectives

By the end of this lesson you will be able to:

1. Discuss the importance of women understanding their reproductive anatomy
2. Identify the major anatomical structures of women’s reproductive anatomy
3. Describe the role of the major sex steroid hormones in women’s reproductive health
4. List 5 signs of a suspicious breast lump and nipple discharge
Required Reading

*Obstetrics and Gynecology at a Glance* (Norwitz and Schorge)

- Chapter 2: Anatomy of the Female Reproductive Tract

Required Article

*Possible Developmental Early Effects of Endocrine Disrupters on Child Health* (World Health Organization)

Key Words

Be sure to familiarize yourself with the definitions for all key terms. These can be found in the course resources or by using an on-line medical dictionary.

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<th>Body Burden</th>
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<td>Endocrine disruptor</td>
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Women’s bodies, strong, powerful, and capable, have been shrouded in myth, mystery, magic, misunderstanding, and taboo throughout history and across cultures. Though many of the prohibitions and misconceptions surrounding women’s sexual/reproductive organs and their functions are now better understood, the vast majority of adolescents and adults today, including most women – even many health professionals – do not adequately or accurately understand the female sexual/reproductive system.

Women’s lack of body knowledge and awareness is problematic because it can lead women to ignore gynecological symptoms, avoid seeking care for gynecologic problems, and can lead to difficult communications between care providers and patients, including non-disclosure of gynecologic symptoms during a routine office visit because of embarrassment. One woman who became my midwifery client, went to her OB/GYN while pregnant to show her a concerning breast lump. The OB was too busy to hear the woman’s concerns and never bothered to do a breast exam at the initial prenatal. A Stage-4 breast cancer lump was missed. Ultimately her labor was induced early so she could undergo a mastectomy. Being diagnosed months earlier wouldn’t have changed this outcome – but the point is, the woman was too embarrassed to bring it up and the doc too busy to ask if the woman had any concerns.

An understanding of the connection between sexuality and health is also missing from contemporary medical discussions of female anatomy, yet such an understanding of the female genital system for women themselves, as well as their practitioners, can lead to improvements in sexual health, and consequently, improvements in general health and self-esteem. Many women find understanding and appreciating their bodies to be radically empowering.
Lack of understanding on the part of the medical community is also problematic, for example, misconceptions about the natural timing and course of labor has led to pandemic levels of labor induction and unnecessary cesarean sections, at the expense of the health and comfort of numerous mothers and babies.

A general understanding of anatomy and women's endocrine functions will facilitate your conceptual understanding of the materials in the remainder of the course, and will help you provide your clients with lifelong understanding of their bodies, which can dramatically impact their health and well-being.

The Language of Women's Anatomy

The medical nomenclature for female anatomical structures can be subtly disempowering to women: Many structures of women's sexual anatomy are named after male physicians or scientists, and some words, for example "vagina" which means a sheath for a sword, reflect an archaic, chauvinistic use of Latin.

Even as recently as the 20th century in the United States, hysterectomy was used as a treatment for women's psychoemotional problems because these were believed to stem directly from the uterus. In fact, the words uterus and hysteria are both derived from the Greek *hysterikos*, or uterus!

Worse yet, in many cultures the words used to describe women's sexual anatomy are negative, derogatory, and oppressive, reinforcing attitudes that potentially endanger the health (and safety) of women and girls. Many women who come to you as clients will have grown up internalizing negative beliefs and attitudes about their bodies in general, and sexual organs specifically.

The Hebrew terms for menopause translate to "age of wilting" or "being worn out."

An Arabic term means "years of despair."

In Japanese, characters used for women's sexual parts conveyed "shame."

The “In Translation” sidebars in the 2011 edition of *Our Bodies, Ourselves* highlight the work of global partners who develop health resources based on *Our Bodies, Ourselves* for their own communities.

To avoid confusion, common scientific terms, unfortunate as some may be, are used throughout this course. It is important to recognize that slang words women use for their own sexual and reproductive anatomy may vary vastly from those used by health professionals, and some of these terms are also derogatory or may be uncomfortable to you. Communicating in various populations requires knowledge of, and comfort with, commonly used terms. Often just asking a woman what words she uses is all you need to do to communicate effectively with her.

Note that this course uses the terms “sexual/reproductive systems” simultaneously, recognizing that not all women will choose or be able to bear children, and that the sexual experience, for mothers and non-mothers alike, is not defined by nor limited to reproduction.
Women’s Sexual/ Reproductive Organs

The female sexual/reproductive organs include:

- the external genitalia
- the vagina
- the uterus
- the ovaries
- the fallopian tubes
- the breasts

Within the sexual/reproductive organs is a collection of glands, vasculature, erectile tissue, nerve tissue, muscles, and ligaments.
Down to the Bones

The pelvic bones form a solid though somewhat flexible cradle that provides the walls upon which the pelvic ligaments anchor the pelvic organs. The bony hips protect the pelvic and lower abdominal organs and provide ample room for the carriage of children in utero (barring a history of disease or malnutrition, i.e., rickets due to Vitamin D deficiency, that interfered with proper growth or development).

The pelvis has two corresponding halves, each containing 3 bones that are in mirror image to the other half. These bones are the ischium, ileum, and pubis. The pelvis also connects with the sacrum and coccyx, the bones that form to lower end of the spine.

Outer Parts

The Vulva

The vulva is the term describing the external female genitalia, the sexual/reproductive organs that are visible upon external visual inspection. This includes the Labia majora, the Labia minora, the clitoris, the introitus (vaginal opening), the urethral meatus (urethral opening), the perineum, and the greater vestibular glands. The vulva is bordered in the anterior aspect by the mons pubis (“mountain on the pubis”, the fatty, hair covered triangle covering the pubic bone) and posteriorly by the anus. With the increasing number of women shaving their vulva, increasing numbers are also experiencing folliculitis and abscesses!

The Labia, Mons Pubis, Greater Vestibular Glands, and Labial Erectile Tissue

The Labia majora (large lips) are the large outer folds that enclose and protect the inner structures of the vulva, a region called the vestibule. Typically 7-8 cm in length, 2-3 cm wide, and 1-1.5 cm thick, their surface is covered by skin on which grows the pubic hair after adolescence, while their interior aspect is covered by mucosa. Fatty tissue underlies the skin, and they are the sites in which the round ligaments terminate.

Anteriorally, the pair of Labia majora meet, forming the prepuce, or “hood” over the clitoris. The Labia minora (small lips) reside inside the outer labia. They are covered with mucus membrane, the soft, moist, pink or light colored delicate tissue that covers the more internal aspects of the female genitalia. The mucosa lubricates during arousal, and the inner labia contain many blood vessels that swell, changing to a darker color as they infuse with blood. A pair of mucus producing glands, the greater vestibular glands, flanks the vagina on each side. They lubricate the distal portion of the vagina during sexual arousal.
There are two specific types of erectile tissue: Corpus spongiosum (spongy bodies), compact masses of specialized capillaries and Corpus cavernosum (cavernous bodies), which contain relatively large vascular caverns. These specialized capillaries contain one-way valves that have the capacity to close with arousal, becoming engorged and increasingly sensitive. The vestibular bulbs make the vaginal opening flexible in size, and also allow the experience of pleasurable sensations. They are easily palpated when engorged. Women have as much of this specialized erogenous tissue as is contained in the male penis, a fact often overlooked, with the majority of medical books excluding over 75% of this tissue from descriptions and illustrations.

The Introitus and the Hymenal Ring

The introitus is the vaginal opening. The hymenal ring, or hymen is a circular band of elastic connective tissue located just inside the introitus. The virginal hymen is typically thicker than in the non-virginal woman, and rarely may be imperforate. After childbirth the hymen appears as skin tags on either side of the introitus.

In most girls and women, the hymen does not normally cover the entire vaginal opening, thus it is impossible to tell, by inspection of the hymen, whether a woman is a virgin. Sadly, in some cultures women are prevented from marrying, are shunned, or may experience far more severe abuse if their hymen is found not to cover the entire vaginal opening on what are routine inspections. The Swedish Association for Sexuality Education (RFSU), a sexual rights group, coined the term vaginal corona and notes, “The mythical status of the hymen has caused far too much harm for far too long,” and the hymen has wrongly been “portrayed as the boundary between guilt and innocence.”

The Clitoris

The clitoris (“hill”), an amazing organ and the key to many women’s sexual pleasure, is located anterior to the vestibule. From the outside it appears as a small, protruding structure under a prepuce, or hood. It is a highly sensitive organ composed of erectile tissue, the surface size of which belies its actual extent and complexity, as well as its important role in women’s sexual experience.

The clitoris is comprised of three major parts, the glans or head, the shaft, and the crurae, as well as the prepuce, frenulum, and clitoral sponge (also called the bulb of the vestibule). The glans is a pea-sized, acorn-shaped structure that contains approximately 4000-8000 nerve endings, the highest concentration in the human
body, male or female. The glans is nestled underneath the prepuce (hood), formed by the juncture of the labia majora. The hood is analogous to the foreskin of the male penis. The glans sits atop the tubular shaft (body or corpus), and together the glans and the shaft are shaped rather like a small penis in contour.

Underneath the hood the shaft of the clitoris can be moved slightly within the loose tube of fibrous connective tissue that surrounds it. At the base of the shaft, the clitoris bends and splits forming the crurae (legs; crura = singular) of the clitoris that extend like a wishbone with the branches following along the inner edge of the pubic arch. The clitoral sponge, the erectile tissue of the clitoris, becomes enlarged, firm and exquisitely sensitive with stimulation. The vestibular bulbs start just lateral to the vaginal orifice, proceed along the sides and extend and connect to the shaft of the clitoris; thus stimulation of one part of the connected tissue leads to stimulation of the other. The frenulum is the junction of the labia minora formed just below the glans. More discussion of this organ follows in the lesson covering women’s sexual function later in the course.

The Perineum

The perineum is the smooth, triangular shaped area of skin-covered tissue lying between the vaginal opening and the anus. It is roughly a 4 cm equilateral triangle, the anterior portion of which meets the introitus, and the posterior portion of which meets the anus. The perineum on all sides meets the musculature of the pelvic floor. It is tough and flexible, and because it has relatively few nerve endings, is not acutely sensitive.

The perineum is designed to adapt to the remarkable emergence of a baby’s head during childbirth. Under the perineum lies another pad of erectile tissue that divides the vagina and the rectum. This erectile tissue is called the posterior or perineal sponge, and like other erectile tissue forms a snug and sensitive cuff around the vaginal opening. The perineal erectile tissue is usually 1/2 to 1 1/2 inches inside the vaginal opening and about 1/2 inch deep, towards the rectal wall. This depth tends to protect against trauma during childbirth; however, it may be severed by episiotomy.

The “Hinterlands”

While not considered part of the sexual/reproductive organs, the anus is an important anatomical landmark observable upon visualization of the external genitalia. The anus is a cone of muscle that forms a two-layered sphincter muscle, which acts as a drawstring-like muscular closure valve. One layer is more external, the other slightly more internal. It is lined with delicate mucosa that is full of highly sensitive nerve endings. The sphincter muscle of the anus is connected to the sphincter muscles of the vagina like a “Figure 8,” with the connection laying under the perineum.

Many women find anal stimulation highly erogenous, so for some it does play a role in sexual activity; however, it is not a part of the reproductive system – rather it is part of the digestive system. Its proximity to the vagina and bladder can result in the spread of bacterial organisms to these other sites, and consequently, bladder or vaginal infection in cases of poor hygiene, disrupted vaginal flora, or susceptibility to urinary tract infection (UTI).
Inner Parts

The Vagina

The vagina is a collapsed, circular, muscular tube. The vaginal tissue is constructed of squamous epithelium (mucosa) underneath which lies a layer of connective tissue and a thin, two-layer muscular coat. The anterior wall of the vagina is typically 5 to 7.5 cm long; the anterior wall generally 7.5 to 10 cm long. The anterior wall is in contact with the posterior bladder wall. While the vagina is commonly thought of as an open tunnel, it is not; the walls touch. It is considered a duct, providing a pathway for menstrual blood, a passage for semen and an exit route for babies. The mucosal lining secretes vaginal lubrication. The lateral vaginal walls form longitudinal ridges, while the anterior and posterior walls form transverse ridges called rugae.

Internally, nerve pathways to another area of erectile tissue, an “internal clitoris”, connect the clitoral structures, which is in the anterior or top wall of the vagina. Dubbed the G-spot for Dr. Grafenberg, who medically described it, it is inaccurately described as a “dime-sized spot”; whereas it is actually a cylindrical tubular structure. The upper third of the vagina, the portion into which the cervix protruded, is called the vault. The grooves on either side of the vagina where the wall and floor meet are referred to as the sulcus. The space created between the body of the cervix and the vaginal walls is the fornix. The ureters and uterine arteries flank the vagina on either side.

The Uterus & Cervix

The uterus is an amazingly strong organ composed of multiple muscle layers capable of expanding to accommodate a baby, and also capable of expelling it through rhythmic contractions; and a remarkable lining (endometrium) capable of the cyclic changes of the fertility cycle and supporting the growth of the placenta and a fetus. It is situated between the bladder and rectum, measuring approximately 7.5 cm in length, 5 cm in width, and 2.5 cm in thickness. Its shape is likened to an inverted pear, the size compared to that of a small fist.

The uterus is divided into three segments: the fundus is the dome-shaped upper portion; the body is the large central segment; and the cervix is a narrow interior portion shaped like the end of a balloon. The cervix protrudes into the upper third of the vagina, and nestles into the back of the vaginal canal. The outer opening of the cervix into the vaginal canal is called the external os; the juncture between the upper aspect of the cervix and the body of the uterus is called the inner os. The portion of cervix between the two os is the isthmus. Inside the cervix are microscopic glandular crypts that secrete special slick mucus during a woman’s fertile time of her cycle. These vaults assist and nourish sperm, facilitating their entry into the uterus and keeping the sperm alive for up to five days.

The three layers of the uterus are the serosa (or perimetrium), which forms the outer layer and is part of the peritoneum; the myometrium, the middle, muscular layer of the uterus; and the endometrium, the lining of the uterus composed of a bilayer of glands. Uterine arteries supply blood to the uterus.
The Fallopian Tubes and Ovaries

From either side of the lateral, top of the uterus (horn) extends a fallopian tube or oviduct. Each is comprised of a long passage culminating in a funnel-shaped, open distal end (infundibulum) from which extend fringed, finger-like projections called fimbriae. Each fallopian tube is approximately 10-12 cm long and is composed of 3 layers: an inner layer containing ciliated and non-ciliated cells; a middle layer of smooth muscle; and an outer layer of longitudinal muscle. These layers work in concert to assist the movement of the egg from the ovary toward the uterus, and potentially toward sperm waiting to fertilize the egg. Much like the uterine endometrium, but without shedding, the epithelial lining of the fallopian tubes undergoes cyclic changes. The stages are called the resting phase, the premenstrual phase, the menstrual phase, and the postmenstrual phase.

At the end of each tube rests an ovary, a small almond-sized organ that contain all of a woman’s eggs from the time she is a six-month old fetus. The ovaries are gonads and as such are the primary organ of reproduction in the female. As is the uterus, the ovaries are maintained in their position by a series of ligaments. They are attached to the broad ligament of the uterus. The ovary undergoes what is referred to as an ovarian cycle, the series of changes that occur in concert with the menstrual cycle. Both the menstrual cycle and the ovarian cycle are described below.

The Urethra

The urethra is a tube that runs from the bladder internally to the vulva, and allows the passage of urine externally. It is located below the glans of the clitoris and above the vaginal orifice. While not a sexual/reproductive organ, the location of the urethra in the pelvis, and its proximity to vagina and uterus, make it an organ that can be affected by gynecologic conditions, and can also affect gynecologic and obstetric problems. For example, urethral meatus irritation frequently accompanies vaginal chlamydial infections, and UTI can lead to vaginal bleeding, and during pregnancy, even premature labor. Therefore it is mentioned in this discussion.

Nerve Supply, Blood Supply and Erectile Tissue

Bundles of nerves form sensitive connections that weave together the aforementioned areas and structures. The most significant nerve bundles, branches of the pudendal nerve, are on either side of the pelvis, at 3:00 and 9:00, near the ischial spines of the pelvis, and located in the far back wall of the vaginal vault behind the cervix. Interestingly, ‘pudendum’ comes from the Latin word for ‘shame’; midwife-educator Sherri Winston suggests it be renamed the primary genital nerve. The entire vagina and pelvis are richly supplied with an elaborate network of blood vessels. All erectile tissue is thoroughly infused with capillary networks.

The Pelvic Muscles

The muscles of the pelvis are arranged much like a hammock, forming a strong sling called the pelvic floor. The muscles stretch from the bottom front edge of the pubic bone, back to the sacrum. Along the sides they attach to the inner and bottom edges of the pelvis. This muscle group is referred to as the pubococcygeus muscles, or PC muscles.
The urethra is surrounded by and passes through the pelvic floor muscles, as does the vagina and the rectum. The PC muscle sling is actually composed of a variety of separate muscles, but for our purposes we will divide them into 3 separate functional groups. The front group that helps prevent unwanted urination, the bottom group, and the back or rear group, which helps prevent unwanted defecation. These muscles surround and support the vagina and other structures within the pelvis and are controlled both voluntarily and involuntarily.

Pelvic Floor Integrity
Keeping the pelvic floor muscles in good tone is important for pelvic integrity throughout a woman’s lifetime – they maintain the proper location of the pelvic organs, ideally preventing organ prolapse and urinary incontinence as a woman ages. It is especially important after childbirth to restore tone to these muscles through deliberate pelvic floor exercise. The most effective non-surgical treatment for the most common types of urinary incontinence is pelvic floor exercise. Women can improve sexual response and satisfaction by learning to identify and use their pelvic floor muscles effectively during sex.

Ligaments
The position of the uterus is maintained through a pair of broad ligaments attaching to the uterus to either side of the pelvis through which also pass the uterine blood vessels and nerves. The cardinal ligaments extend from the bases of the broad ligaments between the pelvic wall, the cervix, and the vagina. The uterosacral ligaments attach the uterus to the sacrum on either side of the rectum. Ligaments are structural, inelastic connective tissues that connect muscle to bone. The round ligaments are unique in that they have a core of muscle fiber and can stretch. They extend from below the fallopian tubes and insert into the labia. They maintain the uterus in an antiflexed position, and are involved in the upward contraction of the uterus during orgasm.

Glands
The Bartholin’s glands, also called the vulvovaginal glands, are located at the bottom of the vaginal opening, at either side at 5:00 and 7:00. They secrete a very small amount of lubrication during arousal; this fluid may help protect the vagina from pathogenic microbes. The Skene’s glands or paraurethral glands are composed of a multitude of tiny rootlike projections that are enmeshed in the erectile tissue that surrounds and protects the urethra. There are approximately 30 multiple ductal apertures that open along the length of the urethra as well as the ducts that open at the urethral orifice, located at either side of the external urethral opening. Both sets of glands have immune functions that maintain a healthy vaginal environment.

Women’s Sexual Response
Each of the structures of the female sexual/reproductive system is connected, forming an elegant network. During sexual arousal, the vaginal walls become moist with lubricating fluid from the mucus membranes as well as that secreted by the vestibular glands. Stimulation of the upper part of the vagina, which is sensitive to a stretching
motion, tactile stimulation of the labia minora and clitoris, and tactile stimulation of the breasts may combine to culminate in orgasm (climax).

During orgasm, autonomically mediated rhythmic contractions of the vaginal wall, and impulses that travel via the pudendal nerves to produce rhythmic contractions of the bulbocavernosus and ischiocavernosus muscles, lead to vaginal contractions that can assist the transport of spermatozoa in the fertilization process. However, conception is not dependent upon these contractions as it can occur in the absence of female orgasm. Sexual function and response will be explored in greater depth in the lesson on sexual health and dysfunction later in the course.

The Breasts

Anatomy of the Breasts

The breasts of an adult woman are tear-shaped mammary glands, developmentally modified sweat glands with the potential for milk production. A layer of subcutaneous adipose tissue surrounds the glands and extends throughout the breast itself, comprising 80 to 85% of the normal breast. The breasts are supported by and attached to the pectoral muscles of the thorax by ligaments. Each breast contains 12 to 25 circularly arranged lobes radiating around the nipple. Each lobe is comprised of numerous lobules containing clusters of alveolar glands that produce milk in a lactating woman.

The alveolar glands transport the milk into lactiferous ducts that drain its respective lobe. Each lactiferous duct widens to form an ampulla, and then narrows prior to termination at openings in the nipple. A band of circular smooth muscle surrounds the base of the nipple while longitudinal smooth muscle fibers extend this ring, encircling the lactiferous ducts as they converge toward the nipple. The adipose tissue and the configuration of lobes determine the size and shape of the breast.

The darker-pigmented area around the nipple is called the areola. It size and color varies from 2 to 6 cm in diameter and from pale pink to deep brown depending on age, parity, and skin pigmentation. The areola contains numerous small oil producing glands called Montgomery’s tubercles which serve to lubricate the areola and which become more pronounced during pregnancy.

The breasts possess arterial blood supply and venous return, as well as a lymphatic drainage system divided into 2 main categories: superficial (including cutaneous) drainage and deep parenchymatous drainage. The lymph system serves to filter infection and protect the body from disease. Additionally, the breast has a nerve supply; the nipple is highly innervated, and for many women, a highly sensitive, erogenous organ.

Women’s breast shape, size, and “tone” are as highly variable as are women themselves. Yet because of a narrow range of acceptable breast appearance in western culture, many women are dissatisfied with their breasts. According to the American Society for Plastic Surgery, nearly 250,000 breast augmentation procedures are performed annually. Breast augmentation for teenagers accounted for 3,841 procedures in 2003. The number of breast augmentations increased seven percent from 2002 to 2003. When physicians were asked the primary reason their patients offered for wanting a breast augmentation, sadly 91% of respondents said it was to improve the way they feel about themselves.
**Cyclic Influences on Breast Tissue**

The breast tissue is highly influenced by the hormonal changes of the menstrual cycle. The three major hormones affecting the breast are estrogen, progesterone, and prolactin. Estrogens cause proliferation of mammary ducts while progesterone causes growth of lobules and alveoli. Many women experience breast swelling, tenderness, and pain in the 10 days preceding menstruation, largely due to distention of the ducts, hyperemia, and edema of the interstitial tissue of the breasts. These changes regress, along with the symptoms, during menstruation and the postmenstrual phase.

During pregnancy, in response to progesterone, breast size and turgidity increase significantly, accompanied by deepening nipple and areolar pigmentation, nipple enlargement, areolar widening, and an increase in the number and size of Montgomery’s tubercles. In response to hormonal signals, the alveoli enlarge and their lining cells, the acini cells, increase in number and size (hyperplasia and hypertrophy). The breast ductal system branches markedly. In late pregnancy, the fatty tissues of the breasts are almost completely replaced by cellular breast parenchyma. Secretion of colostrums may begin during pregnancy. After birth, the fully mature breasts secrete milk in response to prolactin.

During menopause, due to lack of hormonal stimulation, the breast undergoes a process of involution eventually regressing to an almost infantile state.

**The Breast Exam**

Breast cancer remains a leading cause of death for American women. Overall exposure to circulating and environmental estrogens, lifestyle factors, as well as genetic factors, predispose women to this serious problem. New guidelines over the past few years have led physicians to steer women away from performing breast self exams (BSE) because women were finding lumps on their own, going to the doctor for an exam, the doctor was referring for biopsies that then turned out to be negative, leading women to have unnecessary biopsies. The problem, however, in my clinical experience, is not the fact that women doing breast self exams were finding lump and having them evaluated – in fact, many times women are the first to find a cancerous lump either through
BSE or inadvertently. The problem is that many primary care physicians lack confidence in their breast exam skills, thus pretty much whenever a lump is found, a woman is referred for more invasive investigation rather than simply reassured and followed if necessary.

I still recommend that women perform periodic and regular breast exams as part of their self-care. Women should be familiar with what’s going on with their breasts. Additionally, I recommend a routine annual breast exam from a primary care doctor, nurse-midwife, or nurse practitioner confident and skilled in breast examinations. Ideally, the same person should do the exam year after year to be able to feel for and record changes consistently.

**When to Perform a Breast Self Exam**

Hormonal changes associated with the menstrual cycle normally increase breast lumpiness and swelling. These changes are particularly noticeable just prior to the menstrual period. Therefore, it is advisable to perform a BSE a few days to a week after menstruation has ended. Women using oral contraceptives are advised to perform their BSE each month on the day they begin a new package of pills.

Unfortunately, too many women do not carry out this simple technique. Selecting one day each month is the easiest reminder – encourage clients to circle this date on their calendars or post a reminder to them. It is easier to remember once it becomes a routine part of a woman’s life. Pregnant women should continue to perform BSE throughout the pregnancy. An exam should also be performed by the care provider at the onset of pregnancy, prior to the beginning of dramatic pregnancy-induced breast changes, and repeated later in the pregnancy and again postnatally. Pregnancy does not preclude the development of breast cancer. The biggest problem with breast cancer during pregnancy is it going undetected due to lack of regular breast exams, therefore sometimes being allowed to progress further without treatment than had it been detected by early exam.

**Breast Changes and Warning Signs**

- A new lump or hard knot in the breast or armpit
- A lump or thickening that does not decrease in size after menstruation
- A change in the size, shape or symmetry of the breast
- Thickening or swelling of the breast
- Dimpling, puckering or indentation in the breast
- Dimpling, skin irritation or other change in the breast skin or nipple
- Redness or scaliness of the nipple or breast skin
- Nipple discharge, other than breast milk in a lactating woman, especially if the discharge is bloody, clear and sticky, dark or occurs without squeezing your nipple
- Nipple tenderness or pain
- Nipple retraction
- Any breast change that appears to be cause for concern

In 80% of all cases breast lumps and changes do not signal breast cancer. However, women should report all unusual changes to their health care provider and seek a clinical evaluation. Many women put off telling their doctor out of fear—it can be reassuring for patients to know that at least 50% of all women will seek evaluation for a suspicious lump of breast change at some point in their life.
Differentiating Breast Lumps by Palpation

- Normal, non-cancerous lumps such as cysts are typically soft, smooth, and moveable. They tend to fluctuate in size with the menstrual cycle. Also, if a lump, knot, or other “difference” is found in one breast, the women should examine the other breast. If the lump or texture is symmetric between breasts, it is likely to be normal breast tissue.

- Questionable lumps are usually firm, irregular nodules that are fixed in place. They do not typically fluctuate in size with the menstrual cycle.

Warning: A physician should evaluate persistent lumps or abnormalities as soon as possible.

Nipple Discharge

Most suspicious nipple discharges are found to be caused by non-cancerous conditions. In approximately 10% of all cases, nipple discharge is due to cancer. In women less than 30 years of age, less than 10% of nipple discharge is due to cancer.

- Green or yellow discharge is usually normal.

- Bloody, dark, or clear and sticky discharge is considered abnormal.

Warning: A physician should evaluate persistent nipple discharge.

Our Hormones

Hormones are chemicals messengers that provide a means of intercellular communication, serving as chemical regulatory and signaling agents. They orchestrate most of the biological changes occurring throughout our life cycles. They are powerful and yet their balance is delicate and relatively easily disrupted by stressors.

This section provides a brief overview of a complex topic: the primary hormones directly affecting the female reproductive system. It also introduces you to a few important adrenal hormones that affect our energy, sex drive, and mood. Thyroid and adrenal hormones are addressed in greater depth in other lessons, and insulin and insulin resistance are further discussed in required reading. All of these hormones are intimately interconnected and play an important role in women’s reproductive health and dysfunction. While this is a bit of a reductionist review of the physiologic functions of common hormones, this is really an elegant web of biological activity involving every major function of your body – and many that affect your mind and emotions! Let’s take it from the top – the brain, that is!

Pituitary Hormones

The pituitary gland lies in the brain beneath the hypothalamus. It is divided into two major sections: the anterior and posterior lobes. The anterior pituitary contains different cell types that secrete six hormones: adrenocorticotropic hormone (ACTH), growth hormone, thyroid-stimulating hormone (TSH), the gonadotropins
follicle-stimulating hormone (FSH) and luteinizing hormone (LH), and prolactin. The posterior pituitary hormones, oxytocin and vasopressin, are secreted by neurons directly into the systemic circulation. We’ll focus on the gonadotropins (FSH and LH) and prolactin, and learn about oxytocin because it makes us feel great and connected!

**Gonadotropins: FSH and LH**

Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) are called gonadotropins because they stimulate the gonads— in females, the ovaries. Gonadotropins act only on the ovaries in females (and on the testes in males). They work together to regulate the cyclic secretion of the ovarian hormones. FSH and LH have central roles in the regulation of ovarian hormones, and thus, the ovarian and menstrual cycles. Gonadotropin-releasing hormone (GnRH) is the main regulator of LH and FSH secretion. It is synthesized in and secreted by the hypothalamus.

**Follicle-Stimulating Hormone**

FSH stimulates the maturation of ovarian follicles. FSH and LH together are responsible for final follicular maturation.

**Luteinizing Hormone**

Ovulation is induced by a large burst of LH secretion known as the preovulatory LH surge. LH stimulates the secretion of estrogen and progesterone from the corpus luteum. LH is required for continued development and function of the corpus luteum, hence the name luteinizing hormone.

**Prolactin**

Prolactin plays a significant role in reproduction, pregnancy, and lactation. It is secreted by the anterior pituitary and secreted by various immune cells, the brain, and the decidua of the pregnant uterus. Prolactin has been associated with several hundred biological activities, but especially for its actions on the mammary gland, stimulating mammary gland development and milk production.

Prolactin also seems to stimulate maternal behaviors, for example, nest building and retrieval of scattered young, in some animal species. Exercise, and surgical and psychological stresses cause prolactin levels to become elevated. Levels also rise during sleep. Secretion is increased during pregnancy, reaching a peak at the time of parturition. Prolactin also appears to have indirect immune activity, playing a modulatory role in several aspects of immune response.

**Oxytocin**

Oxytocin has been called the “love hormone,” a well-deserved reputation due to its role in social connection, mother-child bonding, breastfeeding, and possibly even orgasm, particularly in women. It enhances feelings of contentment, calm, and reduced anxiety and fear.
This powerful hormone is released in large amounts during labor, simulated by cervical dilatation, facilitating birth, bonding, and, after stimulation of the nipples, breastfeeding. Birth and breastfeeding create a positive feedback loop, enhancing activities such as uterine contractions, milk let-down, and maternal attachment. It may also play a role in romantic attraction.

Oxytocin appears to also play a role in cognitive function, enhancing memory and interestingly not only recognition of human faces, but happy human faces, suggesting a supporting role in positive social behaviors such as empathy, love, and connection.

**Hypothalamic Hormones**

The hypothalamic hormones regulate the secretion of the anterior pituitary hormones. Control over secretion of FSH and LH is exerted by GnRH. GnRH stimulates both their secretion. A regulatory loop leads to pulsatile secretion of LH and FSH which varies in frequency depending upon the stage of the ovarian/menstrual cycle. The pulse frequency increases late in the follicular phase of the cycle, culminating in the LH surge, and decreases in the secretory phase due to the increased presence of progesterone. Close to menstruation, when both estrogen and progesterone are close to baseline, the cycle begins anew. As women age and ovarian function declines, the ovaries become less responsive to gonadotropins so secretion of FSH and LH is increased.

**The Sex Steroids**

The sex steroid hormones are estrogens (estriol, estrone, and estradiol), progesterone, and testosterone. They are divided into groups based on their number of carbon atoms. Cholesterol is the basic unit of steroid metabolism. The ovaries are capable of producing all three classes of sex steroids. Steroid formation also occurs in other organs, for example, the adrenal glands.
**Steroid Hormone Production Cascade**

**Pregnenolone**

Pregnenolone is the building-block for all other steroid hormones. It is converted directly into DHEA and/or progesterone. DHEA then converts to testosterone and estrogens. Additionally, progesterone converts to estrogens, cortisol, and aldosterone.

It is this succession of conversions that makes human life possible. Without pregnenolone, there can be no human steroid hormone production. Made from cholesterol, pregnenolone is a natural steroid hormone produced primarily in the adrenal glands, but in smaller amounts by many other organs and tissues of the human body, including the liver, brain, skin, gonads, and even the retina of the eye. Like many health-promoting hormones, levels of pregnenolone drop with age.
Progesterone

Cholesterol is the building block for progesterone production. Progesterone is a precursor to estrogen and testosterone. Progesterone is considered a secretory hormone. The principal target organs of progesterone are the uterus, the breasts, and the brain, all of which contain progesterone receptors. Progesterone is responsible for the progestational changes in the endometrium and the cyclic changes in the cervix and vagina, influencing the glands of the uterus so that they become capable of secreting glucose and stabilizing the blood vessels of the endometrium so that they are capable of supporting pregnancy. Progesterone has antiestrogenic effects on the myometrial cells, decreasing their excitability and their sensitivity to oxytocin.

Progesterone synthesis in non-pregnant women is the result of a combination of secretion from the ovaries and adrenals. The feedback effects of progesterone are controlled at both the hypothalamic and the pituitary level. After ovulation, the corpus luteum is responsible for a significant amount of progesterone synthesis.

During pregnancy, synthesis also occurs in the placenta. Large doses of progesterone inhibit LH secretion and potentiate the inhibitory effects of estrogens, preventing ovulation. Progesterone stimulates the development of lobules and alveoli of the breast and supports the secretory function of the breast during lactation.

There are two forms of progesterone receptors, progesterone receptor A (PRA) and progesterone receptor B (PRB). PRA is capable of inhibiting some of the actions of PRB, however, the physiologic significance of the existence of the two forms is undetermined.

Progesterone is thermogenic, responsible for the rise in basal body temperature at the time of ovulation.

Progesterone displays important activity in the regulation of blood sugar, inflammation, and stress mediators, acts as a diuretic, and stimulates respiration. It also has a mood elevating effect.

Testosterone

Testosterone is produced by the ovaries and adrenal glands. It enhances libido and sexual response, builds muscle and bone, strengthens ligaments, enhances cognitive function, and is associated with assertive behavior and a sense of well-being. Testosterone influences both stamina and restful sleep, and protects against cardiovascular disease. The adrenal gland secretes androstenedione diurnally in a circadian rhythm similar to that of cortisol. A peak also occurs during the luteal phase, due to secretion by the corpus luteum.

Estrogens

The term estrogen is typically used to collectively describe the sum of all of the circulating estrogens of which there are three primary types: 17β-estradiol, estrone, and estriol. Almost all estrogen comes from the ovary. Estradiol is the strongest of the three estrogens, and estriol the least potent. Androgens are the precursors of estrogens.

Peripheral conversion occurs primarily in adipose tissue, as well as in muscle, hair follicles, the skin, brain, bone, and bone marrow. Two percent of the circulating estradiol is free. The remainder is bound (conjugated) to protein. Estrogens are oxidized or converted to glucuronide and sulfate conjugates in the liver. Appreciable
amounts are secreted in the bile and reabsorbed in the bloodstream (enterohepatic circulation). Conjugated estrogens are also excreted into the intestine where they may either be excreted in the feces, or in the presence of beta-glucuronidase, an enzyme produced by intestinal bacteria, may be reconverted to an active estrogen form reabsorbed into the bloodstream.

Estrogen levels vary throughout the ovarian/menstrual cycle. Two peaks of secretion occur: one prior to ovulation and one during the mid-luteal phase. Approximately a week prior to ovulation estrogen levels begin to increase reaching a maximum level one day prior to the LH peak, after which levels decline dramatically and rapidly. About 5 to 7 days after ovulation, estradiol levels again peak, returning to baseline just before menstruation.

After menopause, estrogen secretion declines to low levels, and aromatization primarily occurs from androgens in adipose tissue and muscle. Very thin women may experience more pronounced symptoms during menopause and may be at greater risk for osteoporosis due to this important lack of an androgen source.

Estrogens are proliferative hormones. They are often referred to as “feminizing hormones,” because the physical development that occurs in puberty, and again during pregnancy — changes in the breasts, uterus, and the vagina — are largely due to the presence of estrogen. Additionally, women’s body shape and fat distribution is due to estrogen. Estrogens stimulate the growth of breast ducts and are responsible for the pigmentation of the areolas, which becomes more prominent during pregnancy.

Estrogens facilitate the growth of the ovarian follicles and increase the motility of the fallopian tubes. They are largely responsible for the cyclic changes in the endometrium, cervix, and vagina, increase uterine blood flow, and affect the smooth muscle of the uterus, increasing myometrial activity and excitability. Estrogens are responsible, in part along with aldosterone, for other cyclic changes of the menstrual cycle, for example, the water and salt retention that occurs before menstruation.
Estrogen also has numerous important effects outside of the reproductive system. It counterbalances the effects of testosterone on the sebaceous glands, which would otherwise lead to acne. It plays an important role in lowering plasma cholesterol and has been shown to prevent expression of factors important in the etiology of atherosclerosis. Estrogen levels decline dramatically with menopause, leading to hot flashes and other symptoms of menopause, and increasing the risk of development of osteoporosis and possibly heart disease.

Two estrogen receptors have been identified: estrogen receptor $\alpha$ (ER $\alpha$) and estrogen receptor $\beta$ (ER $\beta$). ER $\alpha$ expression is primarily found in the uterus, pituitary, kidney, and adrenal gland. ER $\beta$ expression is high in the ovary, lung, bladder, brain, and bone. It has been suggested that the regulation of ovarian function by the pituitary-ovarian axis is primarily ER $\alpha$-mediated, whereas estrogens secreted into the ovarian follicles act primarily via ER $\beta$s.

**Other Ovarian Hormones**

**Relaxin**

Relaxin is secreted by the corpus luteum. Its role in nonpregnant women is unknown. During pregnancy it inhibits uterine contractions, assisting in maintaining the pregnancy. Its primary function is the facilitation of childbirth through relaxation of the symphysis pubis and pelvic joints in late pregnancy, and softening and dilating of the cervix.

**Inhibins and Activins**

Inhibin and activin are ovarian hormones that respectively inhibit and stimulate pituitary FSH secretion.

**Ovarian and Adrenal Hormones**

**Dehydroepiandrosterone (DHEA)**

DHEA, the most abundant circulating hormone, provides protection against the effects of stress and inflammation. It is made primarily by the ovaries and adrenal gland, with smaller amounts produced in the skin and brain. DHEA can be converted into estrogen and testosterone in peripheral fat, muscles, bone and in the liver.

**DHEA:**
- Increases libido and sexual arousal
- Improves motivation
- Fosters well-being, decreases pain, and enhances immune system function
- Enhances sleep and memory
- Maintains cholesterol levels
Cortisol

Cortisol is the primary stress hormone and is made by the adrenal glands. It regulates the blood sugar, immune response, memory, and helps the body adapt to stress by increasing heart rate, respiration, and blood pressure. Without cortisol one cannot sustain life - in fact, when people have been taking steroid medications for a long time, they must always maintain a small supplemental dose as the medication tells the adrenal gland to stop producing cortisol and without the supplement, the person would die of hypotension, immune failure, and a host of organ system failures.

Cortisol levels follow a circadian rhythm, with a peak early in the morning which gives us the energy to get our day going, and a gradual waning throughout the day until it reaches its nadir late in the evening, allowing us to wind down for bed, rest, and repair. If this rhythm is disordered due to stress as described in Lesson 3, women experience adrenal fatigue, or what is commonly called “burn out” or a feeling of being “tired but wired.” Adaptogens and stress reduction techniques are used to restore health.

Sex Hormone Binding Globulin (SHBG)

Estrogens and androgens are either bound (conjugated) or unbound. When they are conjugated they are bound to either SHBG or to serum albumin. The unbound hormones are biologically active. Thus when hormone levels are checked, both free and total levels are often checked. SHBG synthesis occurs in the liver and is increased by estrogens and thyroid hormones, and decreased by the presence of testosterone.

Bringing it All Home

Endocrinology is an incredibly complex and emerging field of science and medicine. What do you need to know? Develop a general sense of the roles - the “flavor,” if you will, of the primary sex hormones (estrogen, testosterone, and progesterone) as well as cortisol, the thyroid hormones, and insulin. But the important take home message from this lesson is that the endocrine system is a tightly interwoven network, much like in a spider web, in that if you touch one strand, the whole web moves. While we can think of our hormonal systems discretely, i.e., sex hormones, adrenal hormones, thyroid hormones, in reality, they are an interconnected, constantly communicating system of rapidly and fluidly adjusting chemical messengers, responding to and dictating our outer and inner worlds.
Select the best answer for the following multiple choice questions.

1. Which of the following is not a part of the external genitalia?
   a. labia minora
   b. the anus
   c. the clitoris
   d. labia majora

2. The strength of the 3 primary forms of estrogen, from least to greatest strength, is ____________.
   a. estrone < estriol < estradiol
   b. estriol < estrone < estradiol
   c. estradiol < estrone < estriol

3. The perineum is located between ____________________.
   a. the uterus and the cervix
   b. the bladder and the urethra
   c. the urethra and the vagina
   d. the vaginal opening and the anus

4. The urethra is not a part of the reproductive system but is discussed in this lesson because ____________.
   a. it is an erogenous site for women
   b. UTIs can result from the proximity of the urethra to the vagina
   c. UTIs are a common gynecologic problem

5. Pelvic floor exercises are often effective in the treatment of female urinary incontinence.
   a. True
   b. False
6. Nipple discharge is always a warning sign of cancer.
   a. True
   b. False

7. If a non-lactating woman has nipple discharge she should probably be evaluated by her physician.
   a. True
   b. False

8. The 3 primary sex steroid hormones are ____________________.
   a. cortisol, insulin, and thyroid hormone
   b. LH, FSH, and GnRH
   c. testosterone, estrogen, and progesterone
   d. LH, FSH, estrogen

9. ________________ serves as a basic building block of steroid hormone synthesis.
   a. Progesterone
   b. Cortisol
   c. Estrogen
   d. Pregnenolone

10. Most estrogen is produced in the ________________.
    a. adrenal glands
    b. fat
    c. ovaries
    d. breasts
11. Progesterone is a precursor to ____________ and ____________.
   a. cholesterol and cortisol  
   b. estrogen and testosterone  
   c. pregnenolone and DHEA

12. Estrogen is considered a(n) ____________.
   a. female hormone  
   b. proliferative hormone  
   c. adrenal hormone  
   d. stress hormone

13. Progesterone is considered a(n) ____________.
   a. secretory hormone  
   b. male hormone  
   c. adrenal hormone  
   d. stress hormone

14. When a woman has a contraction, oxytocin is released. Oxytocin then, in turn, stimulates more contractions. This is an example of ________________.
   a. the menstrual cycle  
   b. a feedback loop  
   c. the let-down reflex  
   d. endocrine disruption

15. Stress can affect prolactin levels.
   a. True  
   b. False
16. The endocrine system is ________________.
   a. a set of discrete hormonal systems
   b. an interconnected network of chemical information
   c. hard to disrupt
   d. separate from the rest of the body, for example, the immune and cardiovascular systems

17. Estrogen levels ________________ after menopause.
   a. decline dramatically
   b. increase dramatically
   c. don’t change much
   d. fluctuate wildly

18. Estrogen levels peak during the menstrual cycles, once prior to ovulation and once during the________.
   a. menses
   b. follicular phase
   c. mid-luteal phase

19. Most nipple discharge is due to ________________.
   a. a cancerous condition
   b. a non-cancerous condition
   c. stress

20. ______________ is the most abundant circulating hormone.
   a. DHEA
   b. Estrogen
   c. Progesterone
   d. Testosterone
CASES, FORMULAS, and REFLECTIONS

Please reflect on these questions and fill in the PDF, answering:

1. What is the importance of a woman understanding her sexual/reproductive anatomy?

2. Ask 3 women if they perform BSE regularly, how often, and if not, why not?

3. Go to a bookstore, newsstand, or online site. Look through “women’s” or fashion magazines and identify three articles either on the use of herbs and dietary supplements, or “women’s health problems.” Reflection: Did the article convey a sense of respect and empowerment regarding women’s bodies and health?

4. Discuss your own observations on how your hormones affect you throughout your cycles, both your monthly and your larger life cycles – for example, think back to around the time of your menarche, pregnancies and nursing if you have children, perimenopause and menopause if you have reached these stages. Talk about your emotions, physical sensations, mental space, creativity, energy levels, etc.

5. Though this might be a bit awkward, make a list (do not submit the list!) of all of the words you can think of for women’s and men’s genitalia – both medical and slang, as well as a list of questions pertaining to sexuality/gynecologic conditions, for example, “Are you having any vaginal itching? Pain during sex?” etc. Ask yourself these questions and use a few choice words out loud in front of a mirror until you can repeat them comfortably and without awkwardness. You are then to repeat this exercise in front of a willing friend (if you have an older teenager they’ll likely get a laugh out of this assignment, and may even be able to teach you a few new words!). Submit a brief summary of your experience and what came up for you as you were doing this exercise.