

Human Reproduction and Development: Important Concepts

For a species to survive, to continue the species' existence and pass on genetic information from generation to generation, it is essential that mature adults can produce fertile offspring. The reproductive system is a collection of organs that work together for the purpose of producing this new life.

The major organs of the reproductive system include the external genitalia and internal organs, including gonads, that produce a gamete through the process of meiosis, in which the number of chromosomes is cut in half from 46 (diploid number: 2 sets) to 23 (haploid number: 1 set). Substances such as fluids, hormones, and pheromones are also important to the effective functioning of the reproductive system.

THE MALE REPRODUCTIVE SYSTEM

The male reproductive system consists of two major parts: the testes, where sperm are produced, and the penis, which deposits sperm in the female reproductive tract. In human males, both of these organs are outside of the abdominal cavity. The testes are carried in a pouch called the scrotum.

Having the testes outside the abdomen ensures survival of the sperm, which require a temperature about 3° C. lower than body temperature (37°) to survive. If the testicles were inside of the body, the higher temperature will likely harm the spermatozoa (sperm), making conception more difficult or impossible.

From the onset of puberty sperm are produced in the lining of hundreds of seminiferous tubules in the testes. From there they travel through a long coiled tube called the epididymis, in which they mature and become capable of moving, and then to the vas deferens and the urethra. (see diagrams).

A mature sperm consists of a head with very little cytoplasm, a midpiece and long flagellum (tail). Enzymes at the tip of the head allow the sperm to penetrate the ovum during fertilization.

The urethra passes through the penis, which contains cylinders of spongy tissue that fills with blood during sexual arousal, causing the penis to become firm enough to penetrate the vagina. During ejaculation about 3.5 ml of semen, containing 200-400 million sperm is expelled. Since many of these die in the female reproductive tract, fertilization requires a high sperm count. Males with less than 20 million sperm/ml of semen are considered sterile.

THE FEMALE REPRODUCTIVE SYSTEM

Consists of the vagina and uterus — which act as the receptacles for semen — and two ovaries, one on each side of the abdominal cavity, which produce the female's ova. The vagina is attached to the uterus through the cervix, while the Fallopian tubes connect the uterus to the ovaries.

OVULATION AND THE MENSTRUAL CYCLE

In response to hormonal changes, normally one ovum, or egg is released from a follicle in

one of the two ovaries during ovulation. The follicle bursts, releasing the egg, which is swept by cilia into the fallopian tube. The follicle, then called the corpus luteum ("yellow body" in Latin) produces progesterone, a hormone signaling the body to prepare for pregnancy.

An ovum is typically released about every 28 days, about 14 days after the onset of menstruation. It moves through the fallopian tube, in which fertilization takes place. If not fertilized, this egg is eliminated during menstruation, about two weeks after ovulation.

Menstruation is the shedding of the lining of the uterus, a hollow, muscular organ about the size of a small fist, which has been preparing for a possible fertilization.

For a period of two or three days after ovulation, the female gamete is readily available to be fertilized by sperm, to form a zygote, the 1-celled beginning of the new organism.

When sperm enter the female's reproductive system, they 'swim' towards the female egg propelled by their thread-like tails. This race towards the egg is fueled by a fuel tank of ATP behind the head of each sperm - providing the energy for its efforts.

After a long journey, many of the sperm will have died in trying to reach the egg, though some still have to the potential to fertilize it. Each reaching the ovum will attach itself to it, but only one will succeed in penetrating it. Enzymes contained in the acrosome (head) of the sperm break down the membrane of the ovum. After one succeeds, the ovum secretes various hormones to prevent penetration by any of the other sperm. The gametes, each containing half of genetic information fuse (join).

The fertilized ovum, or zygote, is a complete, unique human being, with DNA which is different from either the mother or the father and all of the information needed to develop into an adult. Fertilization, or conception, usually occurs 3-5 days after sexual intercourse in which sperm are deposited in the vagina.

HORMONES make this all possible

1. (FSH) follicle stimulating hormone - causes a follicle, part of the ovary, to develop and release an ovum.
2. estrogen - produced by follicle in the ovary, produces female characteristics and prepares the uterus for reception of the zygote
3. (LH) luteinizing hormone - secreted by the pituitary gland, in the brain. In males it stimulates the production of testosterone, and in females it stimulates ovulation.
4. testosterone - produced by the testes induces and maintains male characteristics in animals
5. progesterone – produced by corpus luteum (see above) maintains pregnancy until the 10th week of fetal development, at which time the placenta begins to produce it.

THE ZYGOTE (NEW HUMAN BEING)

Within hours of conception the zygote undergoes cell division. The presence of a hormone called progesterone prevents the production of more ova. Within the first week after conception the fertilized egg travels towards the uterus, where the continued growth of the zygote will occur in the form of an embryo.

IMPLANTATION

Upon arrival in the uterus, the zygote fuses itself to the uterine wall. At this point, cells of the zygote differentiate into two distinct types

Embryoblast Cells - These cells continually divide into what will become the embryo, the baby itself.

Trophoblast Cells - These cells form the placenta, that forms against the uterine wall

THE PLACENTA

is the life support mechanism of the developing embryo, providing oxygen and food for it and removing toxic material and CO² through the umbilical cord, the connection to the mother's bloodstream. Most other substances, including drugs and pathogens also diffuse through the placenta. Alcohol use by pregnant women is a leading cause of birth defects, such as a deformed face and mental retardation.

THE EMBRYO

By the end of the third week after conception the unborn baby is now about the size of an average letter of type in a book.

Towards the end of the first month, the baby's heart starts to beat, while designated cells begin to form the basic structure of the limbs, spine, nervous and circulatory systems. After the initial formation of these major bodily areas, other characteristics such as the eyes, ears and nose begin to develop.

Imaging using ultrasound technology enables doctors to monitor fetal development, including not only external features but also movement. Unborn babies at four month's development have been observed sucking their thumbs. Unlike x-rays, ultrasound does not involve ionizing radiation, which can cause mutations, so it is safe.

By the tenth week after conception human facial and overall characteristics become recognizable.

By the fourteenth week, all the major characteristics of the embryo are developed.

From this time onwards, the fetus will continue to grow in size rather in complexity via cell division. Forty weeks after fertilization the unborn baby is ready to enter the outside world.

DISEASES OF THE REPRODUCTIVE SYSTEM

Many parts of the male and female reproductive systems can be affected by cancer. In

females, cancer can attack the uterus, ovaries, breast and cervix, among other organs. Males can develop prostate, testicular and penile cancer.

Both genders can develop sexually transmitted diseases, including genital herpes, gonorrhea and syphilis. HIV/AIDS, a disease of the immune system, is not exclusively transmitted through sexual contact; sexual activity is one of the ways that the HIV virus is spread.

While genital human papillomavirus (HPV) is commonly associated with females, it is the mostly commonly sexually transmitted infection and most sexually active people in the United States, male and female, will have HPV at some time in their lives. In most people it causes no problems, but in women it can result in cervical cancer and genital warts and in men it can cause penile and anal cancer and genital warts.

For females, one of the more common disorders of the reproductive system is a vaginal yeast infection, which is caused by a yeast fungus in the vagina.

Endometriosis is a condition involving colonization of the abdominal/pelvic cavity with islands of endometrial tissue. If endometrial tissue flushes up the uterine tube during menstruation and spills into the abdomen, the clots of endometrial tissue can attach to abdominal organs such as the bladder, rectum, intestinal loops and then cycle along with the uterus in response to monthly changes in ovarian hormones.

Pelvic inflammatory disease is a condition where bacteria can make their way up the vagina, through the uterus, and traverse the uterine tubes which open into the abdominal cavity.

In women with a prolapsed uterus, the ligaments that hold the uterus in proper position so that it does not prolapse, or herniate, into the vagina, have failed.

Infertility is defined as a couple's inability to conceive after one year of regular intercourse.

In males, infertility is a condition in they produce no sperm cells (azoospermia), too few sperm cells (oligospermia), or if their sperm cells are abnormal or die before they can reach the egg. Chronic problems with ejaculation (sperm released at orgasm) also contribute to male infertility. In rare cases, infertility in men is caused by an inherited condition, such as cystic fibrosis or chromosomal abnormalities.

Epididymitis is inflammation of the epididymis, the tube that lies on and around each testicle and plays a role in the transportation, storage, and maturation of sperm cells.

Hypogonadism is failure of the testicles to produce enough testosterone.

In women, infertility is a disorder of the reproductive system that hinders the body's ability to ovulate, conceive, or carry an infant to term.

Reproductive conditions are treated by a variety of specialists. In women, many issues are treated by obstetricians/gynecologists and for males urologists handle many disorders of their reproductive systems. There are also infertility experts that treat couples who are unable to conceive and endocrinologists who treat hormonal disorders.