Educator's Guide and Script For
Human Body:
The Reproductive System

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INTRODUCTION

The goal of this program is present an upper level high school or introductory premed or pre nursing school overview of the anatomy and physiology of the reproductive system. Using latest in 3-D graphics, medical imaging and for the first time detailed cadaver dissection, this program is designed to maximize student learning. The reproductive system begins with an overview of the evolution of sex and the importance of genetics in human reproduction. Next, pregnancy and how it affects the woman's body is discussed. The program then examines female and male reproductive organs as well as the importance of mating. The program ends with a discussion of female and male puberty and the basics of sex.

ADVANCED VOCABULARY DEFINITIONS

Birth canal: See vagina
Blastocoel: The cavity in the blastula of the developing embryo
Cell division: The process by which cells multiply during the growth of tissues and organs
Cervix: The opening between the uterus and the vagina. The cervix remains closed during pregnancy and dilates during labor and delivery to allow the baby to be born
Chromosomes: The self-replicating genetic structures of cells containing the cellular DNA that bears in its nucleotide sequence the linear array of genes
Conception: In reproduction, the point at which a sperm fertilizes an egg
Double helix: The shape that two linear strands of DNA assume when bonded together, much like a spiral staircase
Embryo: In the reproductive cycle, the stage after the fertilization of the egg that precedes the development into a fetus
Embryonic period: First 10 weeks of gestation preceding the fetal period
Erectile dysfunction: Impotence resulting from a man's inability to have or maintain an erection of his penis
Fallopian tubes: Part of the female reproductive system, these tubes carry eggs from the ovaries to the uterus (or womb

Fetal period: The time period following the embryonic period (first 10 weeks of gestation) until birth
Fetus: A developing human, usually from three months after conception to birth
First trimester: The time period extending from the first day of the last menstrual period through 12 weeks of gestation
Genetic engineering: A way of directly manipulating genetic material in a cell or organism to produce desired traits
Genes: The basic unit of heredity in a living organism
Menarche: The first menstrual cycle, or first menstrual bleeding in the females of human beings.
Menstrual cycle: The monthly cycle of discharge, during a woman's reproductive years, of blood and tissues from the uterus
Menstrual period: When menstrual bleeding occurs. The first day of bleeding is considered day 1 of the entire cycle
Mitosis: Cell division in which the nucleus divides into nuclei containing the same number of chromosomes
Nucleotides: Nucleotides are molecules that, when joined together, make up the structural units of RNA and DNA
Nucleus: A part of the cell containing DNA and RNA and responsible for growth and reproduction
Ovaries: Two small organs inside of a female's body where the egg cells are produced and stored
Pelvic cavity: The space bounded by the bones of the pelvis and containing the pelvic organs
Penis: The external male sexual organ for copulation and urination
Prostate gland: A gland in a man's reproductive system. It makes and stores seminal fluid
Scrotal sac: Also referred to as the scrotum, it is the sac of tissue that hangs below the penis and contains the testicles
Semen: The thick white fluid containing spermatozoa that is ejaculated by the male genital tract
Sex cells: The reproductive cells
Sperm: The reproductive cell or gamete of the male
Testes: Also known as the testicles, they are the male sex glands which manufacture testosterone and sperm
Testosterone: The male sex hormone produced by the testicles that stimulates development of male sex characteristics and bone and muscle growth in males
Third trimester: The time period extending from the 28th week of gestation until delivery
Umbilical cord: The flexible structure connecting the fetus with the placenta; which transports nourishment to the foetus and removes waste
Uterus: Also known as the womb it is the pear-sized female reproductive organ that nourishes the fetus until birth
Vagina: The tube-shaped muscular organ in the female into which the penis is inserted during intercourse and through which a baby passes during birth

Womb: Also known as the uterus, it is the pear-sized female reproductive organ that nourishes the fetus until birth

SCRIPT

HUMAN BODY: THE REPRODUCTIVE SYSTEM

The Miracle of all miracles on this planet is the human body. Now see it in a way never revealed before.

The human reproductive system is different than the body's other systems, different in three important ways. First, all of the other systems are basically identical for men and women. Not so for the reproductive system. The male and female bodies have their own unique set of reproductive structures and organs. Second, the reproductive system doesn't come online until puberty. Lastly, all the other body systems are designed to ensure the survival and health of the individual. The reproductive system is designed to ensure the survival of the species. Join me, Dr. Mark Reisman, as I travel from the microscopic world of genes to embryo development, and finally to the organs of sex. It's all part of human reproduction.

Evolution of Sex

Life on Earth started with single-celled creatures, single-celled creatures that reproduce by simple cell division - one becomes two. This form of reproduction was good enough until multi-celled plants and animals evolved. Now a new way of reproducing was needed. That way was sex, the bringing together of a special cell from two different individuals, one from a male and another from a female. But for a long time how this worked was quite a mystery.

Genetics

Then in the 19th century, a new science arose - genetics, the study of how inherited characteristics are passed on from parents to children. This study is based on cells, cells that contain long chemical molecules called chromosomes, seen here. They carry chemical codes - genes or blueprints - for the making of a new individual.

If you look more closely at the nucleus of the cell, we can see that a remarkable process takes place just before the cell divides, and the mother cell becomes two daughter cells. Out of that dark central nucleus individual strands emerge. These are the chromosomes. Every complex organism's cells contain a precise number of these. Human beings have 23 pairs of chromosomes. During the process of cell division, mitosis takes place, and the chromosomes replicate themselves so that each new cell gets a complete set of chromosomes.

When geneticists looked more closely at the chromosome, they were able to identify genes, genes appearing, not like buttons aligned in a row, but as a region differentiated on the chromosome, a region that contains a sequence of four chemicals - nucleotides symbolized by four letters: T, G, C and A. This is the genetic code, and it is arranged in pairs. We now know that the long strand of DNA - the chromosome - is actually double-stranded, a double strand arranged in the famous spiral double helix.

Returning to reproduction, what happens is that our specialized sex cells, sperm and eggs, divide in such a way that four daughter cells are produced, each containing half the normal number of chromosomes with only one member of a chromosome pair in each cell. When fertilization occurs and the egg and sperm are united, the normal chromosome number - 23 pairs - is restored. The result is that a brand-new genetic code is formed, guaranteeing the uniqueness of the new individual.

Morphogenesis and Pregnancy

So now we come to the uniting of the two specialized sex cells - the male sperm and the female egg. The sperm penetrates the egg. The chromosomes in each combine, and the most miraculous process on the planet begins - the creation of a new individual, a new life.

It is a process that starts with the dividing of a single cell, and then each cell dividing again. After 72 hours, there are eight cells. Around five days the cell mass is still made up of undifferentiated cells - stem cells. That is about to change. An inner group of cells form into a structure called the blastocoel. This will develop into the embryo. Another group of cells form the trophoblast. It'll form into the placenta and attach to the uterine wall of the female. Pregnancy has begun. The human embryo is about to begin a spectacular nine-month journey.

Dr. Jennifer Hronkin is a colleague of mine. She has provided care for hundreds of women through all stages of pregnancy.

Dr. Jennifer Hronkin speaks
Well, Pamela, you're pregnancy test is positive. So let's talk about some of the physical changes you might be noticing in your body over the next few months in early pregnancy. The first change, the most obvious one, and what usually is the thing that brings you in here in the first place is the missed menstrual period. The reason for that is because the uterine lining, which normally sheds and refreshes itself every month is now providing a place for the developing embryo to implant. The next thing that some people will notice, because of hormonal changes and high estrogen levels in early pregnancy is some breast tenderness. And a lot of the time, you'll get some nausea and vomiting too, or otherwise known as morning sickness. There are some circulatory changes that happen to your body in pregnancy as well, that can cause some really intense fatigue and tiredness, and also even some dizziness. And again, this will generally settle down by the time the body kind of reaches an equilibrium at the end of the first trimester. A lot of women are going to notice some heartburn and some increased urination as well. As pregnancy progresses,

you're going to have some weight gain. This is generally going to be after the first trimester you're going to notice the majority of it. The amount of weight that's gained can vary widely, but generally, for an average size woman, we're recommending about 35 pounds.

Inside Pamela's body three structures have already begun to develop, develop in her uterus - the hollow, pear-shaped female organ commonly called the womb. The first of these structures is the placenta. It is an organ that attaches to the wall of the uterus and continues to grow throughout the pregnancy. It performs two very important functions: transferring nutrients and oxygen from the mother to the embryo - later the fetus, and a reverse transfer of waste products and carbon dioxide back to the mother. It also produces hormones that are essential for the mother to maintain pregnancy. The second structure that has already developed in Pamela's body is the umbilical cord. It connects the placenta to the developing embryo. During the first eight weeks of development, the future child is considered an embryo, an embryo that during the first three weeks looks very much like any other vertebrate. But it is during this time that the brain, spinal cord, and heart begin to develop. This is followed in weeks four and five by the emergence of the gastrointestinal tract: intestines, liver, pancreas, the lungs and the four chambered heart have already formed, and arm and leg buds become visible. All this in an embryo that is only 1/5 of an inch long. Next, eyes and ear structures take shape. The backbone and other bones become visible. Arms and legs have grown longer. And foot and hand areas can be distinguished. Hands and feet have fingers and toes but may still be webbed. By week eight, all essential organs have begun formation. Facial features are emerging and the embryo can now move a little on its own.

The conclusion of the eighth week marks the end of the "embryonic period" and the beginning of the "fetal period." The fetus is now just a little over 1 inch long. As the fetus continues to develop during the first trimester, to the casual outside observer Pamela will not appear pregnant. Her belly has yet to significantly expand. But for the fetus inside, the story is quite different and dramatic. By week 12, the genitals are well defined and we can say if it's a boy or a girl. Five weeks later, the baby can hear and move inside the womb. Week 24: the major organs, except for the lungs, are functioning. Hands, feet, and face are fully human.

Bonnie is in the latter stages of the third trimester. She is seeing Dr. Besch for a final sonogram, a nonintrusive medical imaging device that converts sound wave echoes into visual images. As we can see, the baby is highly active. The lungs are now capable of breathing on their own. Bones are fully developed, and eyelids can open and close on their own. Hair covers the head and brain development is rapid, and as we can see, the heart is beating flawlessly. Dr. Besch says all is going well.

Around the 40th week the body's greatest miracle occurs - a new human life enters the world. It's a boy. But if the baby is a girl, she will have already made all the primitive cells - starter egg cells - she will ever have, about 2 million of them. These starter eggs are located in the ovaries, which in turn are located in the pelvic cavity along with other major female sexual organs.

Female Reproductive Organs

Let's look at the female reproductive structures in detail. We have already seen that the uterus - the womb - is the reproductive organ that houses the developing fetus. Above and below the uterus in the pelvic cavity are the other female reproductive structures. Actually part of the uterus is the cervix. The cervix is a tube-like structure that protrudes into the vagina. The vagina, often called the birth canal, is another tubular organ that leads to the outside of the body. Both the cervix and vagina are capable of considerable stretching during the birth of a baby. The vagina also functions as the receptacle of male sperm and the exit point for menstrual blood.

Above the uterus lies two other female reproductive structures - the fallopian tubes and ovaries. Ovaries are small, oval-shaped glands found on either side of the uterus. It is here that the egg cells are produced. Connecting the ovaries to the uterus are the fallopian tubes. Conception, the fertilization of an egg by a sperm, normally occurs in the fallopian tubes. Let's take a unique look at these reproductive structures.

For orientation, this is the diaphragm. We see here the lower portion of the aorta prior to its bifurcation or splitting into the common iliac vessels. And on the right side we see the inferior vena cava returning blood to the heart. These are the two kidneys, and as we explore lower, we can see here this relatively large organ called the uterus. This is an older patient so the uterus is a little smaller than what we may anticipate seeing in a younger female. Coming from the uterus and going laterally are the fallopian tubes, and these tubes are responsible for the transit of the eggs from the two ovaries, which are the most lateral aspects of the female reproductive system.

Male Reproductive Organs

The male reproductive organs, unlike the female's, are largely outside the body cavity. They include the penis, testes and a number of supporting tubes and structures.

When looking at the male reproductive organs, the obvious place to start is with the primary male sexual organs: the testes. These two egg-shaped organs are located in the scrotum, a skin pouch that is suspended outside the body. The testes perform the dual role of producing the male sex hormone, testosterone, and of course, sperm. Sperm combines with fluid from the prostate gland. The result is semen, a fluid that enters the urethra and exits through the penis. Also outside of the body, the penis is made of soft, spongy tissue. Interestingly, the urethra serves a dual purpose: it transports semen through the penis, and it is also the tube that carries urine from the bladder.

Human Mating

So, if you've had a kid, or can remember back to around the time when you were 11 or 12, big changes in the body were taking place. The body was getting ready, not to

replicate itself, but to engage in sex and the starting of a new life that will help repopulate the species. For most animals this repopulation is a closely regulated affair.

Regulated not only by sexual maturity, but also by the rhythms and cycles of nature. For example, many birds mate in the spring. Other animals, such as elk and deer, in the fall. These are annual events, triggered by the short-term fertility of the female member of the species.

But humans are different. Once we reach sexual maturity, we can engage constantly in sexual activity and reproduction. Women can typically bear children from the onset of puberty to well into their 40s. And men can reproduce until their deaths in old age. But unlike most other animals, our sexual drive extends beyond the reproductive years. However, there is a general decline in sex capability with age, and an increased rate of erectile dysfunction in men.

As a result, sexual activity and reproduction have become controlled not by nature but by culture and technology. Sexual mores are as diverse as there are societies. And in many cases, sex and reproductive control have become part of religious practices and morals. And, of course, birth control has provided the possibility of sex without resulting in pregnancy. All of these controls present challenges as puberty is reached and the natural demand to engage in sexual activity and reproduction arises. It is a demand that arises as the body, for both males and females, undergoes dramatic changes, both internal and external.

Female Puberty

Dr. Jennifer Hronkin speaks
Pubertal changes in girls generally begin between the ages of 8 and 13 years. The first sign that a girl is entering puberty is usually breast development. And the first menstrual period, or menarche, is generally going to happen within 2 years after that. Now the age of menarche has actually gone down in recent centuries. Theories about why this is include improved health and nutrition. Some changes that tend to happen before menarche in a girl are an increase in height, an increase in hip width, and development of hair in the armpits, groin, and legs. Menstrual cycles at first tend to be quite irregular, but often will become more regular, and eventually occur around once a month. A girl is generally done with her growing by the age of 17 years, and any increases in height after this are pretty uncommon.

Male Puberty

Puberty in boys could start as early as ten years old. The onset of puberty begins when the testicles and scrotal sac grow larger. This is followed by the appearance of pubic hair, and is often accompanied by a growth spurt, a growth spurt that can last four to six years. At the beginning of this growth spurt the penis enlarges and the classic voice change begins, a substantial lowering of the voice. Two years after the pubic hair appears, hair starts growing on the face and under the arms. It's also the time

troublesome acne shows up. In general, male reproductive readiness lags behind the female's.

Sex

But it's quite likely that it will take many years before pubescent teens actually reproduce. Tyler and Kira are having a romantic dinner. They have finally decided to start a family of their own. An event they have put off until they reached financial stability and feel comfortable that their love for each other is true and enduring. Much has been written about what draws people together for the purposes of reproduction: love, chemicals, social demands and so on. But much is still a mystery.

Tyler and Kira will go home this evening and engage in sexual intercourse. If they are lucky, this will be the first step in initiating a successful pregnancy. Genetically speaking, their goal is to mix the body characteristics of each other to form a unique individual. Each has a specialized group of cells - the sex cells. Tyler's sperm, with their characteristic head and tail, are one of the smallest cells in the human body. Kira's eggs, rich in nutrients, are the largest. In spite of their differences in appearance, each carries a complete set of genes - a blueprint for a human being.

For Kira, hundreds of thousands of eggs rest dormant in her ovaries. Each month since puberty, chemical triggers have released just one egg into her fallopian tubes.

In Tyler's lifetime he will produce enough sperm to repopulate the earth many times over. But tonight he is hoping one sperm will make the nearly impossible journey. A journey during which millions will die.

Upon sexual arousal, the sperm are deposited in the vagina and immediately begin a mad dash into the cervix and then on into the uterus. Most are already dead. It is survival of the fittest, and only the strongest and healthiest make it to the fallopian tubes.

As for Kira, if in the last 48 hours an egg has been released from one of her ovaries and has moved into one of the fallopian tubes, it will await the arrival of a successful sperm, the sperm that has made the right choice, a choice as to which fallopian tube contains the egg.

Finally, about 100 sperm reach the awaiting egg in as little as a half an hour. But only one is successful and penetrates the egg's outer membrane. Conception. Nine months later we can see the end result of this evening's internal body activities.

There is no greater miracle than the development of a new baby boy or girl - the creation of life. This is the miracle of the reproductive system, and perhaps no other system offers greater possibilities for medical miracles in the future, than the possibilities of genetic engineering. I'm Dr. Mark Reisman.

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