

Prenatal Development

Prenatal development refers to the period of development from conception to birth and is divided into three stages.

- The first stage, or germinal period lasts for the first two weeks of pregnancy.
- The second stage, is the period of the embryo. It lasts from the second to the eighth week.
- The third stage is the fetal stage. It lasts from the ninth week until birth. The average pregnancy lasts 270 days or 40 weeks.

At **ovulation**, a mature **follicle** in the woman's ovary ruptures to release an **egg**. Once released, the egg will survive for only 24 hours if not fertilized. If the egg meets a sperm on its journey down one of the **fallopian tubes** to the **uterus**, **fertilization** may occur. Up to 350 million sperm are released in a single **ejaculation**, but fewer than 1 in 1,000 manage to pass through the **cervix** into the uterus, and only around 20 reach the correct fallopian tube to meet the egg. **Sperm** remain active in the fallopian tubes for about 48 hours, but a few hardy ones, may remain active for up to 5 days. At the moment of **conception**, a single sperm is drawn into the egg, which then blocks entry to other sperm. The fertilized egg produces a hormone called **HCG** that "switches off" the menstrual cycle. After conception, the **zygote** repeatedly divides as it travels down the fallopian tube toward the uterus where it will eventually become attached to the uterine wall.

If the mother is carrying multiples [twins, triplets, etc.] it is due to one of several possibilities. There are two types of twin pairs, **monozygotic** [identical twins] and **dizygotic** [fraternal twins]. Monozygotic twins occur when the fertilized ovum divides abnormally - creating two separate zygotes. Both zygotes embed into the uterine wall and develop separately. Monozygotic twins have identical genotypes and are frequently studied by psychologists interested in the **nature versus nurture** controversy - since they share the same genes but have different environmental influences. Dizygotic twins are the result of two ova being fertilized by two different sperm cells. Triplets or larger sets of multiple births are produced this same way. Fertility drugs meant to stimulate the release of ova during ovulation often cause multiple births.

Prenatal development is most successful if the mother has good prenatal medical care, good nutrition, is between the ages of 16 and 35, and does not expose the developing fetus to the harmful effects of **TERATOGENS**. Teratogens are any agents that may cross the placental barrier from mother to fetus causing abnormalities. Possible teratogens include maternal disease, diet, drug use, exposure to X-rays, and other environmental toxins. Maternal stress over an extended period of time can also cause fetal damage. Stress causes the release of the hormone adrenalin which passes through the placenta barrier and enters the bloodstream of the fetus. Adrenalin increases the motor activity of the fetus and increases fetal heart rate. If this occurs over an extended period of time it can cause stunted prenatal growth, low birth weight, or birth complications.

The kind and severity of the birth defects – caused by teratogens – depends on the timing of exposure. Whenever a body part or organ is forming or growing rapidly – exposure to harmful agents can damage that part or organ. These time periods are called **critical periods**. A critical period is any time during development that some developmental process must occur or it never will. For example, if something interferes with legs developing or forming prenatally, they will not develop or be formed later.

Germinal Stage: The first two weeks after conception. The zygote is a microscopic mass of multiplying cells. It travels down the fallopian tube and implants itself on the wall of the uterus. By the time it reaches the uterus, it is a ball of around 100 cells called a **BLASTOCYST**. Before implantation, the fertilized egg divides rapidly, but stays the same size and encased in the protective zona. In order to implant and grow further, the blastocyst erodes a hole in the zona so that it can squeeze through and bury itself in the uterine lining. The blastocyst arrives in the uterus on average six days after conception. In the six days between conception and implantation the **endometrium** becomes thicker, more receptive, and “sticky” to encourage implantation. Not all fertilized eggs implant, and implantation occasionally occurs outside the uterus. If the passage of the egg is blocked, it may implant in the fallopian tube – as an **ectopic** pregnancy. The endometrium is only actually receptive to implantation for one to two days each month. Hormones also thicken cervical mucus so that it forms a plug in the cervix, which protects the uterus during pregnancy from infections that might otherwise travel up from the vagina. The outer layer of the blastocyst burrows into the endometrium and will become the placenta. The inner cell mass forms the early embryo – these cells then differentiate into a two-layered embryonic disk. The fluid-filled cavity develops into a yolk sac that will provide nourishment for the embryo during the early weeks, until the placenta has developed. The **PLACENTA** – which provides nourishment and allows wastes to pass out to the mother - begins to form during this time. The **UMBILICAL CORD** also forms and it will carry nourishment and waste between the placenta and baby throughout pregnancy. Thin membranes keep fetal and maternal blood-streams separate.

Each month, the chance of conception is around 40 percent. The first clue that conception has occurred may be a slight implantation bleed, which can be confused with a very light period, although a missed period is usually the first definite sign that a woman is pregnant. At this stage the uterus has not yet noticeably increased in size, but as a result of enhanced blood flow it is much softer.

Embryo Stage: Second to eighth week after conception. Successful implantation is vital for the growth of the blastocyst into the early embryo. The implanted blastocyst develops at a very fast rate. By four weeks the foundations have been laid for the future embryo. The neural tube is forming, so is the heart. The embryo is less than one inch long by the end of this stage – about the size of a raspberry. Most vital organs and bodily systems begin to form. Major birth defects are often due to problems that occur during this stage. The amniotic sac, a fluid-filled sac that surrounds the embryo, protects and provides a constant temperature for the embryo. The amniotic fluid protects the fetus from trauma and provides space for it to grow and move. It aids lung development and helps maintain the fetus at a constant temperature. At first it is similar to the plasma in the fetal circulation, but as the fetus’s kidneys start to

produce urine, this passes into the amniotic fluid. By the end of the pregnancy the fluid is more concentrated and similar to urine. Fetal swallowing removes a little amniotic fluid from the sac each day. As pregnancy advances, amniotic fluid volume steadily increases, reaching 1 ¾ pints by 32 weeks, but can be as much as 3 ½ pints.

Organogenesis is a process of rapid embryonic development – as the major organs and external structures form. It lasts from the 6th to the 10th week. Different systems develop at the same time. The first fully functioning system is the cardiovascular system, which consists of the heart and a simple circulation that is continuously remodeled as the embryo develops. The heart develops early, to allow nutrients to be circulated - to support the embryo's development. It is the first system to work fully. The heart beats from day 50, and blood starts to circulate two to three days later. The fetal heart is lined with a special lining called endocardium, and the muscular tissue of the heart [myocardium] is unique in its ability to contract spontaneously with a regular intrinsic rhythm. Blood cell production in the liver - starts at 37 days. Some blood production occurs in the bone marrow from as early as 10 weeks but the liver remains the dominant site until after birth. Red blood cell production is high. Each fetal red blood cell survives for only 60 days – half that in the adult. The embryo needs iron, folic acid, and vitamin B12 to produce sufficient red blood cells.

Lung development begins at day 50 and continues into early infancy. The simple windpipe develops two branches that subdivide into repeatedly finer tubes. The initial branching pattern is common to all embryos, but the final arrangement is unique. The lungs are not developed enough for gas exchange to take place until 38 weeks.

Fetus Stage: From two months after conception until birth. This is a time of rapid growth. Muscles and bones form. Vital organs continue to grow and begin to function. Pregnancy is a delicate balancing act, and most miscarriages occur in the first 12 weeks. The mother's immune system needs to accept the developing embryo, which would otherwise be detected as foreign and attacked – at the same time the immune system must be strong enough to defend against infections.

The fetus's brain develops throughout pregnancy. By the third month, major changes have already occurred. The **thalamus** is the largest element of the brain, acting as a relay station for the hemispheres. The cerebral hemispheres expand rapidly, although they are smooth at this stage, not achieving the familiar folded appearance until late in the second half of the pregnancy. This is only the start of brain development, which, unlike the other embryonic systems, undergoes major changes throughout pregnancy.

By the 5th month, some of the nerve **axons** linking the fetal limbs to the spinal cord are developing a fatty outer coating. This process is known as **myelination** – the nerves are electrically insulated so they can carry messages without affecting neighboring nerve cells. After myelination, messages pass more easily from the brain to the body – and from the body to the brain. As a result, fetal movements become

faster and more coordinated rather than being slow and jerky. Myelination continues throughout fetal life and early childhood.

Exactly when a fetus becomes aware of its surroundings is unclear. The first connections between brain cells – called **synapses** – form during the 12th week of pregnancy, but it is thought that true awareness does not start until around the 20th week. Different types of awareness develop, such as ‘quiet’ awareness, when the fetus is awake but seems to rest, and “active” awareness, when it is awake and moves, often quite strongly. The fetus reacts to sounds within its mother’s body, and noises in its external environment. As myelination and brain development progress, the fetus’s awareness of its own body and its movements will increase.

By the 22nd week the bones within the fetus’s inner ear are beginning to harden, and the coiled **cochlear** membrane is sufficiently developed to process low-frequency sounds. Over the coming weeks, the fetus starts to be aware of higher sound frequencies, too. The nervous system is now developed enough for the fetus to start recognizing the sounds inside the uterus, the mother’s breathing, heartbeat, stomach, and intestinal rumbles, and her voice. It may be noticeable that the fetus becomes increasingly responsive to sounds, and it will develop a startle reaction to loud noises. As the nervous system develops, the fetus becomes able to make much more sophisticated movements, such as kicking and turning somersaults, and the mother will be aware of this increased internal activity.

By the 24th week the parts of the fetus’s brain involved in vision and hearing are becoming more active. Memory is developing, and brain-wave activity is now similar to that of a newborn infant. The mouth and lips show increased sensitivity, and the fetus hiccups and yawns more often than before. Growth of the body and legs has caught up with the head. Teeth buds for the adult set of teeth are appearing in the gums, and the nostrils are opening.

By the 26th week the framework for the gray matter or **cortex** of the fetus’s brain is now in place. This is the location of nerve activity associated with consciousness, personality, and the ability to think. Around this time, fetal hand coordination dramatically improves. The fetus can close its hands to make a fist and may spend a lot of time sucking its thumb. The brain surface is still looking smooth but as the cortex continues to mature, it will start to fold and form normal wrinkles.

During the final trimester, important fetal developments include the laying down of fat, and the maturation of the body systems so that they can function fully on their own after birth. The respiratory system has to undergo a dramatic transformation to enable breathing for the first time. To assist this, special cells in the lining of the air sacs produce a substance called **surfactant**; this lowers surface tension, allowing the lungs to inflate easily. By 35 weeks the lungs are producing surfactant. The fetal brain continues to expand during these last three months, so the head circumference increases from around 11 inches to 15 inches. At the same time, the fetus’s total body length increases from roughly 15 inches to 19 inches, and its weight rises from an average of 3 pounds to 7 ½ pounds. The final 10 weeks

are a period of rapid growth, with the fetus gaining half of its final, full-term weight. By the end of this trimester, the fetus is fully formed and may have settled into a head-down position ready for birth.

At 57 weeks, fetal development is considered complete, and a fetus is classified as full-term. Around 1 in 10 is born before this milestone and is recorded as a premature or “**preterm;**” the earlier it is born, the more complex and numerous the problems. The fetus’s body now has a good layer of fat and looks healthy and plump. It is ready to be born.

Timeline:

Approximate prenatal week	Fetal Development
2nd week	Implantation on uterine wall
3rd-4th week	Heart begins to pump
4th week	Digestive system begins to form.
5th week	Ears begin to form
6th week	Arms and legs first begin to appear
7th-8th week	Male sex organs form
8th week	Bones begin to form Legs and arms move

10th-11th week	Female sex organs form
12th week	Fetus weighs about one ounce Fetal movement can occur
20th week	Mother feels movement Reflexes-sucking, swallowing, and hiccupping appear
27th week	Fetus weighs about two pounds
38th week	Fetus weigh about seven pounds
40th week	Full-term baby born