



Encyclopedia of Human Development

Prenatal Development

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Book Title: Encyclopedia of Human Development

Chapter Title: "Prenatal Development"

Pub. Date: 2005

Access Date: December 11, 2015

Publishing Company: SAGE Publications, Inc.

City: Thousand Oaks

Print ISBN: 9781412904759

Online ISBN: 9781412952484

DOI: <http://dx.doi.org/10.4135/9781412952484.n493>

Print pages: 1019-1020

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Prenatal development can be divided into three stages: preimplantation, embryonic, and fetal. The preimplantation period, between fertilization and implantation of the conceptus in the uterine wall, takes an average of 7 days. The embryonic period is considered to be the major period of organogenesis, lasting about 2 months from conception. During the fetal period, lasting until about 38 weeks after conception, growth, functional maturation, and further differentiation of tissues occur.

The prenatal period is highly sensitive to disruption by toxic substances because of the high rate of cell division and the intricate and complex coordination among chemical, cellular, and genetic processes that is necessary for normal development. Toxic insults to the conceptus are thought more likely to be lethal during the preimplantation and embryonic periods than the fetal period. The timing of an exposure or event has a dramatic influence on the developmental effects that will likely result. For example, alterations of hormones such as prostaglandins and the progesterone–estrogen balance can prevent implantation, resulting in embryonic death. During organogenesis, when the molecular, cellular, and morphological structural organization of tissues and organs takes place, the embryo is considered to be most susceptible to structural defects. Animal experiments show that the exact timing of exposure to a teratogen affects the pattern of structural malformations. However, malformations usually occur in more than one organ system because of overlap in the sensitive period of development of different systems. Functional effects and growth retardation, rather than malformations, are considered to be the most likely outcomes of toxic exposures during the fetal period. However, there are exceptions to these generalizations. For example, skeletal abnormalities in mice can be induced during the preimplantation stage.

Susceptibility to teratogens or other causes of untoward birth outcomes also depends on species, genetic characteristics, and the history of the mother herself. Examples of species and genetic influences on the effects of a teratogen are that mice and rats were found to be resistant to the induction of limb defects by thalidomide, whereas rabbits and hamsters showed variable effects, and some species of primates were highly sensitive to the teratogenicity of thalidomide. The life history of the mother can also affect outcome. For example, the sensitivity of the fetus to alcohol appears to increase with the age of the mother, and recent findings suggest second-generation effects of prenatal influences such as nutrition. A female child born during a famine is more likely to give birth to a low-birth-weight infant, regardless of her own nutritional during pregnancy.

Prenatal exposures can create behavioral and psychological effects by altering aspects of early brain formation such as cell proliferation, dendritic and axonal differentiation, neuronal migration, apoptosis (programmed cell death), synaptogenesis, and myelination. Exactly how alterations in these aspects of brain development create specific behavioral and psychological outcomes is unknown but being studied. Examples of disruptions of intracellular and extracellular processes that can affect brain development include altering ion channels, adhesion molecules on neural cells, hormonal concentrations and balance, neurotransmitter production, and oxidative stress. For example, methylmercury and lead are both thought to alter ion channel functioning and calcium distribution, which in turn may disrupt the neural architecture of the brain. Methylmercury also creates oxidative stress, which, in turn, can cause neural cell death. PCBs (polychlorinated biphenyls) are endocrine disruptors that may alter thyroid functioning of the fetus or mother. Maternal stress alters the levels of hormones

such as cortisol, adrenocorticotrophic hormone (ACTH), and corticotrophic-releasing hormone (CRH), all of which can influence the development of the fetal hypothalamic-pituitary-adrenal axis and promote premature birth. In rodents, prenatal stress reduces male sexual behavior and increases emotional behavior in offspring. Insecticides and nicotine alter the concentrations of neurotransmitters that direct embryonic and fetal neural development and affect processes such as apoptosis.

The effects of prenatal toxicants also depend on the dose, the degree to which and form in which a substance is transmitted across the placenta to the fetus, and the developmental status of the fetus's ability to process the toxicant. Higher doses normally increase the likelihood of adverse effects. Transfer across the placenta depends partly on variables such as molecular weight and structure, protein binding, lipid solubility, and ionic charge. Once a potential teratogen enters the fetus, the detoxification of the substance depends on the maturity of the liver, kidneys, and metabolic and enzymatic processes. The toxicity of substances depends not just on initial chemical structure but also on metabolic transformation. For example, ethanol (the alcohol used in beverages) is converted into acetaldehyde, which is itself teratogenic.

The wide variety of potential toxic insults to the conceptus raises the importance of health care and information for pregnant women and women planning pregnancy. In 1985, the U.S. Institute of Medicine concluded that prenatal care is important for the prevention of low birth weight and recommended policies to make prenatal care available to women regardless of eligibility for public aid. Because low birth weight is a risk for a wide range of development problems, including infant mortality, prevention is important. Low birth weight can result from either premature birth or intrauterine growth restriction. In the two decades following the recommendation, the infant mortality rate in the United States fell. Whether this is due to improvements in prenatal care, improved neonatal critical care, or both is unclear. Some segments of the population have not benefited from these policies as much as others. In particular, African Americans with income below the poverty line have higher rates of low-birth-weight infants and higher infant mortality rates than the rest of the American population.

There is also some controversy about whether current prenatal care practices are truly effective in preventing low birth weight. Prenatal care should consist of early and continuing maternal and fetal risk assessment, health promotion, medical and psychosocial interventions, and follow-up. Late initiation of prenatal care (fourth month or later) is associated with higher rates of many types of congenital defects. This finding could be the result of preventative information or treatments during prenatal visits, or it could derive from the fact that late initiation of prenatal care is a signal for poor health behaviors, poor health care utilization, or poor health care availability.

Although one aspect of prenatal care is promoting health behaviors that are important for infant outcome, as many as one third of pregnant women are not advised about eliminating alcohol, tobacco, and illicit drugs during prenatal visits. To develop more effective prenatal care, future research requires better measures of prenatal care content, quality, timing, and prenatal care provider characteristics and training. Examination of the relations between specific components of prenatal care and child and maternal health and behavioral outcomes is also needed.

An emerging area of prenatal care is the prevention of the transmission of human immunodeficiency virus (HIV) to the fetus. HIV can be transmitted from mother to child

during pregnancy, during labor and delivery, and after birth. Most mother-to-child transmission occurs during birth and delivery. The likelihood of perinatal transmission of HIV can be greatly reduced by antiretroviral drug therapy for the mother during pregnancy, treatment of the infant shortly after birth, and avoidance of breast-feeding. As a result of more vigorous prenatal HIV testing and counseling in the United States, between 1992 and 1996 the number of newborns diagnosed with HIV fell by more than 40%.

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<http://dx.doi.org/10.4135/9781412952484.n493>

See also

- [Neonate](#)
- [Preterm Infants](#)

Further Readings and References

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