A zygote is the fertilized egg that contains genetic material from both the egg and the sperm and its brief lifetime is called the germinal stage. Contrary to what many people think, fertilization does not happen right away. It typically happens 1 to 2 days after intercourse, but can happen as many as 5 days later. The genetic sex of the individual is determined at the time of fertilization; fertilized eggs containing an XY sex chromosome complement are genetic males, whereas those containing an XX sex chromosome complement are genetic females.

By the time an infant is born, its body contains trillions of cells, each of which came from the original zygote. During the germinal stage, the zygote migrates down the fallopian tube and implants itself in the wall of the uterus. Half of them don't complete it, because they are defective or implant themselves in an inhospitable part of the uterus. Male zygotes are especially unlikely to make the journey. In an ectopic pregnancy, the egg attaches itself somewhere outside the uterus — usually to the inside of a fallopian tube.

The embryonic stage begins when the zygote successfully implants itself within the uterine wall. This stage begins at the end of the second week and lasts until about the 8th week. Cells continue to divide and they begin to differentiate.

This occurs because of Hox genes, a subset of homeobox genes, are a group of related genes that specify regions of the body plan of an embryo along the head-tail axis of animals. Hox proteins encode and specify the characteristics of 'position', ensuring that the correct structures form in the correct places of the body. If it is a male embryo, it begins to produce testosterone.
Fetal Stage

- The fetal stage lasts from 9 weeks up until birth. In neurology, what is most important is myelination, the formation of a fatty sheath around the axons of a neuron, both shielding the axons from each other, and speeding up neural transmission.

- As the embryonic brain continues to grow, each subdivision folds onto the next one and begins to form the structures easily visible in an adult brain.

- **Ontogeny**: how a brain develops within a given individual.

- **Phylogeny**: how a brain develops within a particular species.

- The rudimentary brain areas found in simple invertebrates eventually evolved into our complex brain structures, all from that original neural tube.

- In all vertebrates, the central nervous system is organized into a hierarchy, the top of which is the forebrain.

- In higher vertebrates, the forebrain evolves in two different patterns; reptiles and birds have almost no cerebral cortex, while mammals have a highly developed cerebral cortex, with multiple specialized areas.

- The human forebrain shows substantial refinement such as self-awareness, language use, abstract reasoning and imagination.
Prenatal development continued

The prenatal stage: of the 200 million sperm that travel to the womb, only 200 enter the correct fallopian tube, getting close enough to an egg to release digestive enzymes that erode egg's protective outer layer, the egg will then release a chemical that seals the protective coating. 12 hours later, the egg will merge with the nuclei of the sperm, creating a zygote, containing the 46 (23m + 23f) chromosomes of both the egg and the sperm.

During the germinal stage (2 weeks) the zygote migrates down the fallopian tube and implants itself into the wall of the uterus. Male zygotes are especially unlikely to complete this journey, which includes the perils of being genetically defective or implanting themselves in an inhospitable part of the uterus.

- **Embryonic** stage lasts from the second week until about the eighth week. Body divisions such as arms and legs appear, and XY embryos begin to produce testosterone.

- The **foetal** stage is the period of prenatal development that lasts from the ninth week until birth. It has a skeleton and muscles, and is capable of movement. Myelination occurs, the formation of a fatty cholesterol sheath around the neurons, speeding up neural transmission.

- A neonate (newborn) human brain is only 25% of its adult size. Why? One of our species greatest talents is to adapt to a wide range of novel environements, and requires plasticity and neurogenesis.
Genes are sections on a strand of DNA, organized into large threads (chromosomes) which form into a double helix.

The DNA is our chromosomes produces protein molecules through the action of messenger RNA, which communicates a copy of the DNA code to cells to produce proteins.

Sharing traits: the most genetically related people are **monozygotic** twins.

**Dizygotic** twins develop from two separate fertilized eggs and share 50% of their genes.

**Twin studies** are an important part of developmental psychology; usually there is a comparison of monozygotic twins raised together, and apart, to study the interaction of genetics and environment.

Discovering that monozygotic twins share a higher percentage of a specific trait suggests a genetic influence.

The likelihood of a dizygotic twin developing **schizophrenia** is 27%; that for monozygotic twins is 50%.

Genetics can contribute to the development, likelihood, or onset of a variety of traits.
Epigenetics: environmental influences that determine whether or not a gene gets expressed, the DNA sequences that constitute the gene are not altered.

Epigenetic marks: DNA methylation; Histone methylation; the former switches genes off, the latter on and off. Neither alters the underlying DNA.

Epigenetic marks left by DNA methylation and histone methylation play a role in learning and memory.

Studies of nurses working in high or low stress environments found differences in DNA methylation in the two groups.

Heritability is the measure of the variability of behavioural traits among individuals that can be accounted for by genetic factors. The index: 0 (that genes do not contribute); 1.0 (genes are the only reason) for the individual differences.

Almost nothing in human behaviour is completely due to the environment or genetics.

An heritability of .5 = half of the variability is due to genetics.

Heritability tells us nothing about specific genes; nor about an individual. It is a technique for describing differences in individuals across a population.

Heritability is meaningful only for the environmental conditions in which it was computed.
Several studies have linked epigenetic changes with responses to stress. Zhang & Meaney, 2010. Nurses working in high-stress versus low-stress environments found differences in between the two groups in DNA methylation. (Alasaari et al., 2012)

- DNA and histone methylation also play a key role in long-lasting effects of early experiences in both rats and humans. These effects are accompanied by physiological changes.

- High LG (licking & grooming) mother rat: increased serotonin in the hippocampus; decrease in DNA methylation (turning genes off) of glucocorticoid receptor gene related to stress; greater expression of the gene. Result? A greater ability to respond calmly to stress. High LG pups grow to be 'chilled out' adults with better regulated stress response.

- Low LG (licking & grooming) mother rat: decreased serotonin in the hippocampus; increase in DNA methylation of glucocorticoid receptor gene (related to stress); reduced expression of the gene. Low LG pups grow into adults with less ability to respond calmly to stress.

- The human equivalent of high LG is probably loving and attentive parenting. McGowan (2009) reports a role for epigenetics in the persisting effects of childhood abuse on adult men. Kundakovic et al. 2015 report a connection between this abuse and later depression, schizophrenia, and post-traumatic stress disorder.
Prenatal Environment

Placenta physically links the bloodstream of the mother to that of the embryo.

- Children of mothers who receive insufficient nutrition enter the world with both physical and psychological problems, the first being **low birth weight**.

- Rifkin (1994) reported that a birth weight of less than 2500 g was significantly more common in patients with schizophrenia than in those with **affective psychosis**. Schizophrenic patients as a group had significantly lower mean birth weight, a finding which was particularly marked after controlling for **sociodemographic confounders**.

- Antisocial personality disorder is also more likely. Boyle 2011 reports an increase in psychopathology in young adults born with extremely low birth weight.

- **Teratogens** are agents that impair prenatal development, such as alcohol, drugs and viruses. We will examine **FASD** in detail in Web Article One. Tobacco is another, both first- and second-hand smoke.

- The embryo is more vulnerable to teratogens than the foetus, but the central nervous system is at risk until birth.

- A foetus cannot see, but it can hear, preferring the sound of it's mother's voice above all else; newborns will cry with the inflections of their mother's language.
Infancy

- Newborns can see detail at 6.1 metres; they are quite visually responsive for stimuli 20 to 50 cm away, just the distance between the baby's and the mother's face.

- Newborns **habituate** to visual stimuli, losing interest in sameness, and quickly noticing novelty. (Slater, Morrison & Somers, 1988).

- Newborns are especially sensitive to social stimuli. They have been shown to mimic facial expressions in the first hour of their life (Reissland, 1988) and mimic speech sounds as early as 12 weeks (Kuhl & Meltzoff, 1996).

- Infant motor development is the emergence of the ability to execute physical actions.

- Infants are born with a small set of **reflexes**, specific patterns of motor response that are triggered by specific patterns of sensory stimulation. Rooting and suckling are the most prominent.

- Most reflexes disappear within the first few months as infants learn to execute more sophisticated motor behaviours. An involuntary walking reflex can become voluntary walking (Zelazo, 1983).
Motor Development

- **Cephalocaudal** rule: the 'top-to-bottom' rule that describes the tendency for motor skills to emerge in sequence from the head to the toe.

- **Proximodistal** rule: the 'inside-to-outside' rule that describes the tendency for motor skills to emerge in sequence from the centre to the periphery. Infants learn to control their torsos before their arms and legs; this is the reason that they have to cry.

- Memorize **Piaget's Four Stages of Cognitive Development** (Table 11.1) for the next exam.

- **Schemas** are an infant's theories about the way the world should work; here we are applying the concept of 'phenomenological intentionality'.

- **Assimilation**: infants successfully apply their theories to novel situations.

- **Accommodation**: infants' theories do not map out reality; infants must revise.

- **Object permanence**: the belief that objects continue to exist even when they are not visible. Infants demonstrate this belief much earlier than Piaget realized (Shinskey & Munakata, 2005).

- The impossible drawbridge event; the broken line; statistician in the crib.
Childhood Cognition

Pre-operational stage: begins at about 18 to 24 months and lasts until 11 to 14 years.

Pre-operational children do not fully grasp the fact that they have minds and that these minds contain mental representations of the world. They do not yet distinguish between subjective and objective, illusion and reality.

- **Conservation**: the notion that quantitative properties of an object are invariant despite changes in the objects appearance. Conservation of mass shown in pix.

- **Concrete operational** stage: begins about 6 years and ends at about 11 years, during which the child learns how various actions of 'operations' can affect or transform 'concrete' objects.

- **Formal operational** stage: for Piaget, the final stage of cognitive development that begins at the age of 11. Abstract reasoning and hypothesis testing.

- **Egocentrism** is the failure to understand that the world appears differently to different people.

- Young children can understand another's desires (emotions) much better than another's beliefs (Repacholi & Gopnik, 1997).

- **Theory of mind**: understanding that human behavior is guided by mental representations.
Autism & Theory of Mind

• Although children with autism are typically normal on most intellectual dimensions, they have difficulty understanding the inner lives of other people.

• Autistic children have difficulty that others can hold false beliefs; they struggle to understand belief-based emotions such as embarrassment and shame.

• The age at which children acquire a theory of mind is influenced by: the number of siblings; frequency of pretend play; imaginary companions; socioeconomic status of the family.

• Language skills are the most important factor in determining a child's theory of mind, especially if they are exposed to psychological words like want, think, know and sad.

• Language with complex grammatical structures, whose subjects are thoughts and feelings are an important tool for helping children make sense of their own and others' minds.

• Piaget remixed: modern psychologists see development as more fluid and continuous, more mature behaviours will fluctuate with less.
Vygotsky

- Vygotsky noted that cultural tools, such as language and counting systems, exert a strong influence on cognitive development.
- The arbitrary 'twelve' (English) vs. 'ten-two' (Chinese) may put children learning to count in English at a disadvantage.
- **Joint attention** allows a children to learn from others. When a 12-month old infant interacts with an adult who then looks at an object, the infant will typically look at the same object, but only when the adults eyes are opened.
- Early on, infants mimic adult's intentions, rather than their actions (*There's intentionality* applied, again).
- Infants will stop and use another person's reactions to determine if their action is safe or not.
- Infants use social information in a very sophisticated way. When their senses provide unambiguous information about their world, they will ignore what their caretakers tell them. They will accept parental advice when they are unsure. (*Tamis-LeMonda et al., 2008*)
Harlow's monkeys

- Harry Harlow discovered that infant rhesus monkeys who were warm, safe and well fed, but not allowed to any social contact for the first six months of their live developed behavioural abnormalities. Eg: they compulsively rocked back and forth while biting themselves.

- In experiments, Harlow's monkeys preferred the comfort and warmth of a cloth mother to the wire mother, even though the later was associated with food.

- Konrad Lorenz was the first to document duck **imprinting**. When a duckling hatched, it would imprint on the first thing it saw, human or tennis ball, to the extent that it would ignore its own mother.

- Human infants have evolved cries, gurgles, and coos to keep their caregivers close to them, this is an example of a behavioural adaptation.

- Attachment is the emotional bond that forms between newborns and their primary caregivers. It can be either **secure** or **insecure**.

- The kind and quality of attachment is tested using the **Strange Situation**.

- Attachment styles come from **temperament**, based in genetics.

- Attachment also displays the **internal working model of relationships** between the infant and the primary caregiver. This is 'phenomenological intentionality' again.
**Moral development**

- Piaget's Three: realism to relativism (moral rules are inventions, not discoveries); prescription to principles; outcomes to intentions (accidentally vs. Purposefully).

- Kohlberg's Three: preconventional; conventional; postconventional.

- A single person may use all three of Kohlberg's stages in different situations (Walker, 1988).

- So what does create morality? Is it emotion, rather than reason? Study the **Trolley Problem** for the next exam. Your response is an example of the **availability heuristic**.

- Moral judgments may be the consequences and not the causes of emotional reactions (Haidt, 2001). This is the **moral intuitional** perspective.

- Why? Because watching someone suffer activates the same brain areas that are activated when we suffer. (Carr et al. 2003)

- Our brains respond to other's expressions of suffering by creating within us the experience of suffering. (de Waal, 2012).

- Even small children consider it wrong when someone hurts someone else, especially if that person is similar to the child. (Hamlin et al., 2013).