PROVERTO
Educational Publishers • Opvoedkundige Uitgewers

free study guide

Guiding the leaders of tomorrow

2025

www.proverto.co.za

GR 11 & 12

LIFE SCIENCE

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

WSU
Walter Sisulu University
In pursuit of excellence

NELSON MANDELA UNIVERSITY

DUT
DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE
Creative. Distinctive. Impactful.

UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF FINANCE AND INVESTMENT MANAGEMENT

MILPARK EDUCATION

UFS
UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

NELSON MANDELA UNIVERSITY

Change the World by applying for a qualification in one of the following study fields:

Accounting • Advertising • Afrikaans • Agricultural Management • Analytical Chemistry • Anthropology • Applied Design • Applied Mathematics • Architectural Technology • Architecture • Art • Auditing • Biochemistry • Biokinetics • Botany • Broadcasting • Building • Business Management • Business Studies • Ceramic Design • Chemistry • Civil Engineering • Clinical Psychology • Computer Science • Communication Networks (IT) • Conservation Biology • Construction Economics • Construction Management • Construction Studies • Counselling Psychology • Chemical Process Technology • Development Studies • Dietetics • Economics • Ecology • Education • Electrical Engineering • English • Environmental Health • Environmental Management • Emergency Medical Care (Paramedic) • Fashion • Financial Accounting • Financial Planning • Fine Art • Foundation Phase Teaching • Forestry • French • FET Teaching • Game Ranch Management • Geography • Geology • Graphic Design • History • Hospitality Management • Human Movement Science • Human Resource Management • Human Settlement Development • Industrial Psychology • Industrial Engineering • Information Systems • Information Technology • Inorganic Chemistry • Interior Design • Internal Auditing • Inventory Management • Intermediate Phase Teaching • isiXhosa • Journalism • Language & Literature • Law • Logistics • Management • Marine Biology • Marine Engineering • Marketing • Mathematics • Mechanical Engineering • Mechatronics • Media, Communication & Culture • Microbiology • Music • Medical Laboratory Science • Medicine & Surgery • Nature Conservation • Nursing • Operations Management • Painting • Pharmacy • Philosophy • Physiology • Photography • Physics • Political Studies • Polymer Technology • Psychology • Public Administration • Public Management • Public Relations Management • Quality Management • Quantity Surveying • Radiography (Diagnostic) • Restoration Ecology • Renewable Energy • Sculpture • Senior Phase Teaching • Social Work • Sociology • Software Development • Sport Management • Sport Science • Statistics • Support Services (IT) • Taxation • Textile Design & Technology • Tourism • Transport Economics • User Support Services (IT) • Visual Arts • Wood Technology • Zoology

Change the World

E info@mandela.ac.za

T 041 504 1111

myfuture.mandela.ac.za

The examination will consist of two examination papers of 2½ hours and 150 marks each. The weighting and assessment of topics in Paper 1 and Paper 2 will be as follows:

Paper 1

Topic	Time	Weighting	
		%	Marks
T 1			
• Meiosis	1 week	**7**	**11**
• Reproduction in Vertebrates	½ week	**4**	**6**
• Human Reproduction	3 weeks	**21**	**31**
T2			
• Responding to be environment (humans)	4 weeks	**27**	**40**
T3			
• Human endocrine system	1½ weeks	**10**	**15**
• Homeostasis in humans	1 week	**7**	**11**
• Responding to the Environment (plants)	1 week	**7**	**11**
T4			
• Human impact (Grade 11)	'2½ weeks'	**17**	**25**
Totals	**14**½weeks	**100%**	**150**

Paper 2

Topic	Time	Weighting	
		%	Marks
T 1			
• DNA: Code of Life	2½ weeks	**19**	**27**
• Meiosis	1 week	**7**	**12**
T 2			
• Genetics and Inheritance	4 weeks	**30**	**45**
T3			
• Evolution through Natural Selection	2 weeks	**15**	**23**
T 3/T4			
• Human evolution	4 weeks	**29**	**43**
Totals	**13½ weeks**	**100%**	**150**

Extracted from:
National Curriculum Statement (NCS)
Curriculum and Assessment Policy Statement
Further Education and Training Phase
Grades 10-12

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

CONTENT:

DUT

DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

2025 Applications to Study @DUT

Open

FACULTY OF ACCOUNTING & INFORMATICS

FACULTY OF APPLIED SCIENCES

FACULTY OF ARTS & DESIGN

FACULTY OF ENGINEERING & THE BUILT ENVIRONMENT

FACULTY OF HEALTH SCIENCES

FACULTY OF MANAGEMENT SCIENCES

Apply today via the Central Applications Office (CAO):

WWW.CAO.AC.ZA

For more information on our programmes visit: www.dut.ac.za

DurbanUniversityOfTechnology @DUT_Tweets @DUTCampusTV @DUT_Official1
@DUT_Official Durban University Of Technology

ENVISION2030

transparency • honesty • integrity • respect • accountability
fairness • professionalism • commitment • compassion • excellence

CREATIVE. DISTINCTIVE. IMPACTFUL.

1. LIFE AT THE MOLECULAR, CELLULAR AND TISSUE LEVEL

DNA: THE CODE OF LIFE

Deoxyribonucleic acid (DNA)

What is DNA?

Deoxyribonucleic acid (DNA) is called the 'code of life'. It carries the genetic information that controls the synthesis of specific proteins. Proteins are responsible for all the characteristics in an organism.

Location of DNA in the Cell

DNA is found in the form of Chromosomes in the nucleus of eukaryotic cells. A small amount of DNA has been found in mitochondria and plastids. DNA that is found outside the nucleus is known as Extranuclear DNA. Chromosomes is the long coloured threads inside the cell nucleus and they carry the hereditary information in the form of genes. A *Gene* is a part of a strand of DNA that codes for a particular characteristic, for example: height and eye colour.

The Structure of DNA

DNA is a double-stranded polynucleotide. A polynucleotide is a very long molecule made up of a string of repeating, similar units called nucleotides.
There are four different kinds of nucleotides. Each consists of three parts:

- a deoxyribose sugar molecule
- a phosphate molecule
- a nitrogen base

These three parts are attached to each other in a specific way. The phosphate group is joined to the deoxyribose sugar that is joined to the base. The bonds that connect these three parts result in an "L" shaped nucleotide.

There are four different nitrogen bases:

- Adenine (A)
- Thymine (T)
- Guanine (G)
- Cytosine (C)

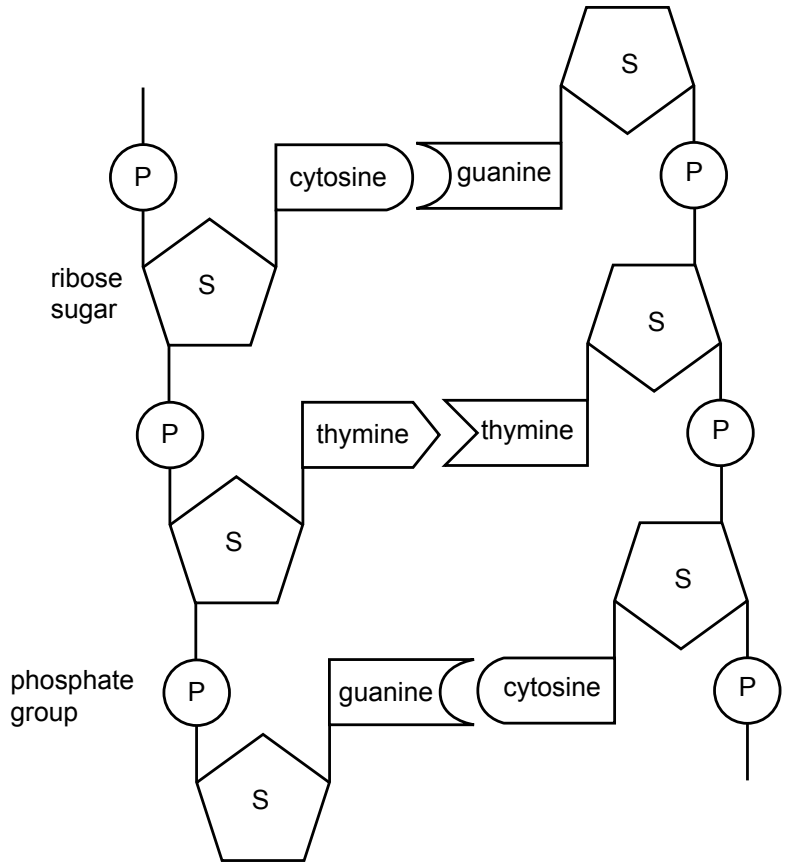
Adenine and guanine are purine bases.
Thymine and cytosine are pyrimidine bases.

The ladder shape of the DNA molecule results from the paring of a purine base with a pyrimidine base, and are called complementary base pairing.

A specific pyrimidine will always pair to a specific purine:

- Adenine joins with thymine, this base pair is bonded by two hydrogen bonds.
- Cytosine joins with guanine, this base pair is joint by three hydrogen bonds.

DNA Structure



Replication of DNA

The cell cycle

At the start of mitosis, the dividing stage of the cell cycle, each chromosome is made up of two chromatids. A chromatid consist of one DNA molecule. During mitosis, the chromatids become known as the daughter chromosomes. They move apart into the two daughter cells. Each daughter cell will contain identical DNA and is also identical to the parent cell.

Replication

- The DNA molecule unwinds and untwist.
- The two strands unzips as the weak hydrogen bonds break. The two strands separate.
- Each single strand of DNA acts as a template for the formation of a new DNA strand.
- By means of hydrogen bonds, free nucleotides in the nucleus pair up with their complementary bases on the two single strands of DNA.
- A new strand is built on each strand, forming two separate and identical DNA molecules.

Ribonucleic acid (RNA)

What is RNA?

Ribonucleic Acid (RNA) is a single-stranded polynucleotide. It is made up of a single chain of nucleotides. The nucleotides of RNA consist of a ribose sugar, a phosphate group and one of four bases: uracil, cytosine, guanine or adenine.

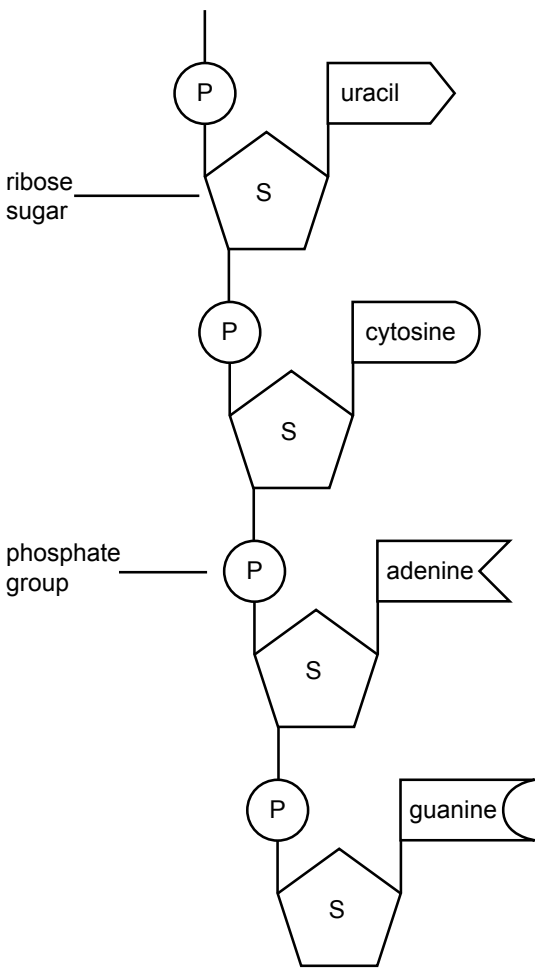
Types of RNA

- **RNA (mRNA):** It is a straight polynucleitide strand. The mRNA carries information about the amino acid sequence of a particular protein from the DNA in the nucleus, to the ribosome where the protein will be made.
- **Ribosomal RNA (rRNA):** It has no definite shape and makes up most of the structure of the ribosomes. Ribosomes are the site of protein synthesis.
- **Transfer RNA (tRNA):** It is a small molecule with a clover leaf shape. The tRNA transport amino acids in the cytoplasm to the ribosome where they are joint together to form a protein. The protein is formed according to the genetic code that is carried by the mRNA molecule.

Location of RNA in cells

RNA is found in the nucleus and in the cytoplasm of the cells.

RNA Structure



MEIOSIS

Chromosomes

Each chromosome consists of different genes. A gene carries information about a specific hereditary characteristic of an organism. Genes are part of the DNA that makes up the chromosome.

Each animal or plant species has a specific number of paired chromosomes. The matching chromosomes in each paired are called ***homologous chromosomes***.

Each chromosome of a homologous pair comes from one of the parents.

The human species contain 46 chromosomes or 23 homologous pairs of chromosomes. One set of chromosomes comes from the mother ***(maternal chromosomes)*** and the other set of 23 chromosomes comes from the father ***(paternal chromosomes)***.

The display of the set of chromosomes from a nucleus arranged in an ordered way is called a ***karyotype***.

The chromosomes pairs 1 to 22 are called the ***autosomes*** that carry genes for body characteristics. The 23rd pair consists of the ***sex chromosomes***. The sex chromosome in human males consist of one X chromosome and one Y chromosome (XY). The X and the Y chromosome differ in size and shape. The sex chromosome in human females consist of two X chromosomes and have the same shape and size (XX).

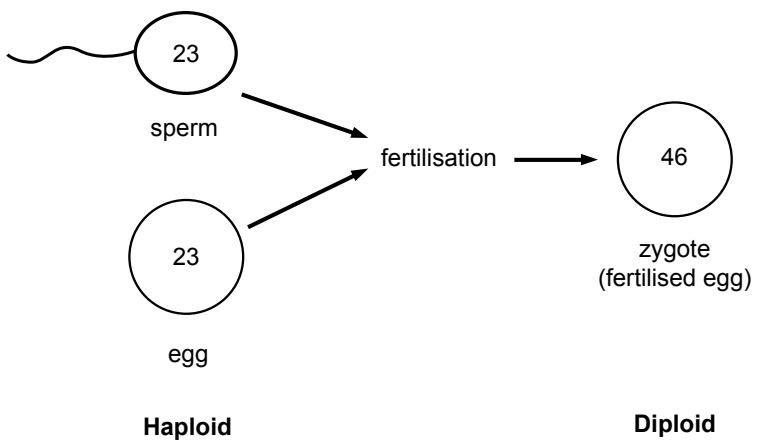
The chromosomes are brought together at fertilisation, the nucleus of the male's sperm cell fuses with the nucleus of the female's ovum to form a ***zygote***.

The process of reduction division

Before sexual reproduction can take place, an organism needs to make gametes, the production of gametes is called ***gametogenesis***.

In animals, gametes form by a process called ***meiosis***. Meiosis is referred to as a reduction division because it halves the number of chromosomes in the nucleus of a cell.

A male or female gamete has only one set of chromosomes and is a ***haploid cell***, other body cells have two sets of chromosomes and are ***diploid cells***.



The process of meiosis

Meiosis can be divided in two separate nuclear divisions:

1. First meiotic division: The diploid chromosome number is halved by the separation of the homologous chromosomes, resulting in two daughter nuclei with half the number of chromosomes of the parent nucleus.
2. Second meiotic division: Each of the haploid daughter nuclei formed by the first meiosis division, divides again to form four haploid daughters nuclei.

The first meiotic division (meiosis I)

Prophase I

- The chromatin network contracts and form visible chromosomes.
- Homologous chromosomes pairs up. Each homologous pair is called a bivalent chromosome pair.
- The homologous chromosomes move apart, but cannot separate due to the chiasmata that holds the chromosomes together. An exchange of genetic material takes place between the chromatids of each homologous pair as the chromatids break and exchanges segments.
- The nuclear membrane and nucleoli disappear.
- The centrioles move to opposite poles of the cell.
- Spindle threads are formed between each centriole, across the length of the cell.

Metahase I

- The bivalents *(homologous chromosome pairs)* arrange themselves on the equator of the spindle, attached to the spindle fibres at their centromeres.

Anaphase I

- The spindle threads contract and pull the chromosomes, the chromosomes separate and move to the opposite poles of the cell.

Telophase I

- The chromosomes group at the poles.
- Cyrokinesis *(division of the nucleus)* is complete.
- The splitting of the cytoplasm takes place.
- Each daughter cell has half the number of chromosomes as the parent cell.
- Each chromosome still consists of two chromatids joint by a centromere.

The second meiotic division (meiosis II)

The second meiotic division is similar to mitosis.

Prophase II

- The spindle reforms, at right angles to the spindle of Meiosis I.
- The nuclear membrane disappears.
- Each chromosome consists of two chromatids joined at the centromere.

Metaphase II

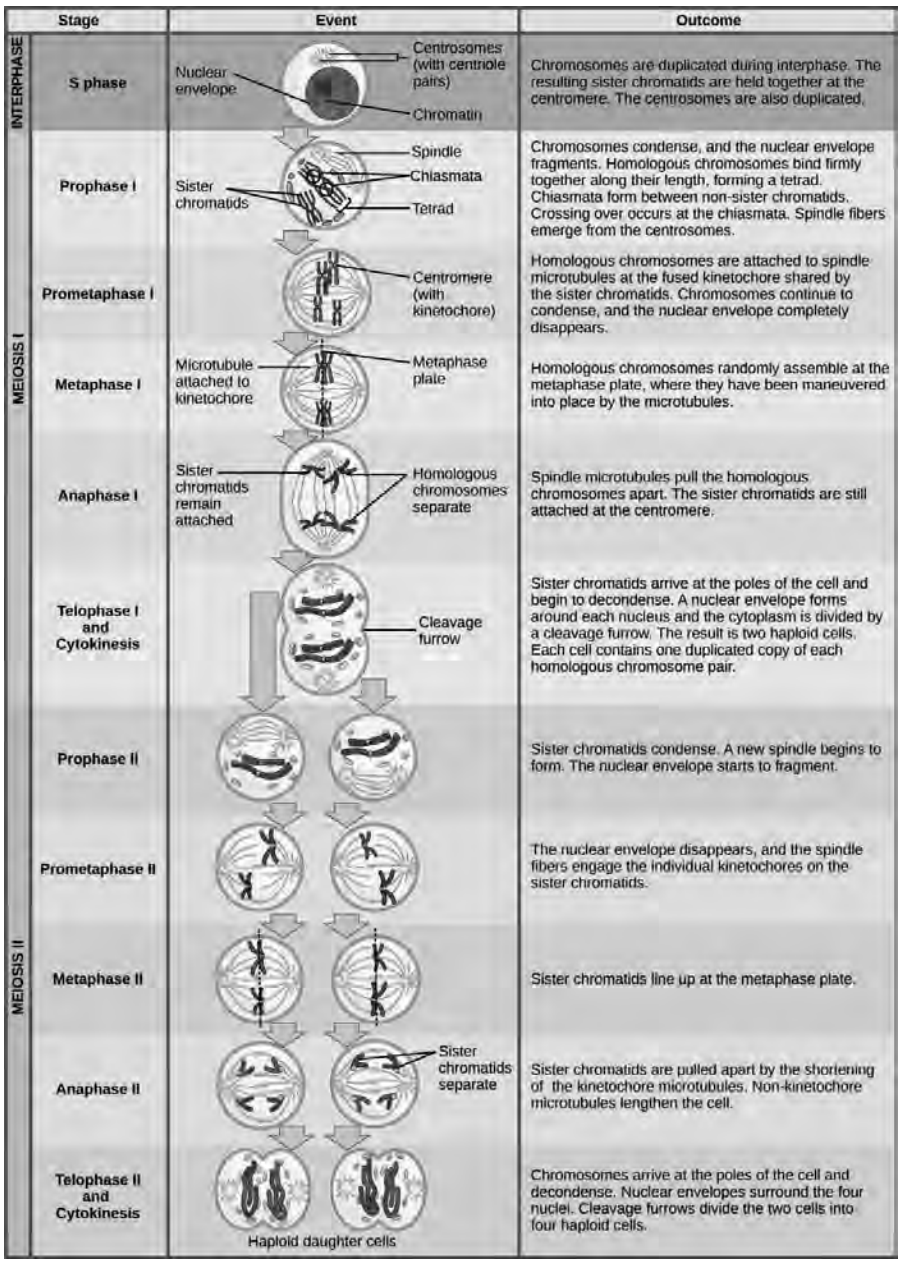
- Individual chromosomes line up at the equator of the spindle.

Anaphase II

- The centromeres divide and the chromatids separate. The individual chromosomes *(daughter chromosomes)* move to opposite poles of the spindle.

Telophase II

- Chromosomes reach the poles of the spindle.
- The spindle breaks down.
- A nuclear membrane forms around each of the four sets of chromosomes.
- Cytokinesis follows and results in four haploid daughter cells that are genetically different.



OpenStax College, "The Process of Meiosis," OpenStax_CNX, February 24, 2014, http://cnx.org/content/m44469/1.8/.

MILPARK EDUCATION

M

EXPLORE OUR

Comprehensive Undergrad
ONLINE Programmes

Your Pathway to Success

Learn More

www.milpark.ac.za

We've got you. You've got this.

The importance of meiosis

Meiosis produces gametes. ***Gametes*** contain half the amount of DNA found in the somatic cells of the species. Gametes are involved in sexual reproduction.

The process ensures that a parent passes its genes to its offspring during sexual reproduction. It also ensures that the offspring vary, since each receives a combination of genes from two parents.

Consequences of abnormal meiosis

Down syndrome

Sometimes chromosome pair 21 does not separate when the egg cell is formed in humans, this results in an egg cell with an extra chromosome 21 or 24 chromosomes instead of the normal 23. The cell has three chromosomes 21 (Trisomy 21) and a total of 47 chromosomes. The extra chromosome 21 results from non-disjunction of chromosome 21 during gamete formation.
If the chromosome 21 fuses with a normal gamete with just one chromosome 21, the zygote will have three copies of chromosome 21.

Comparison of mitosis and meiosis

Similarities between mitosis and meiosis

- Both Mitosis and Meiosis are forms of cell division.
- Both Mitosis and Meiosis occur within the nucleus of the cell and go through the same steps known as Prophase, Metaphase, Anaphase and Telophase.

Differences between mitosis and meiosis

Mitosis: Takes place within somatic cells *(cells that make up the body).*
Meiosis: Takes place within gamete cells *(sex cells).*

Mitosis: The number of chromosomes per nucleus remains the same after division.
Meiosis: The meiotic products contain a haploid (n) number of chromosomes in contrast to the (2n) number of chromosomes in mother cell.

Mitosis: There is no pairing of homologous chromosomes.
Meiosis: During prophase I, complete pairing of all homologous chromosomes takes place.

Mitosis: There is no exchange of DNA (crossing-over) between chromosomes.
Meiosis: There is at least one crossing-over or DNA exchange per homologous pair of chromosomes.

Mitosis: Two daughter cells are produced.
Meiosis: Four daughter cells are produced.

Mitosis: Completed after one division.
Meiosis: Completed after two divisions – meiosis I and meiosis II.

2. LIFE PROCESSES IN ANIMALS

REPRODUCTION IN VERTEBRATES

Diversity of reproductive strategies

Vertebrate animals reproduce sexually, fertilisation needs to take place for the vertebrate animals to reproduce successfully. Fertilisation is when the female and male gametes join to form a zygote. Fertilisation can be either internal or external.

Internal fertilisation

Internal fertilization which takes place inside the female body. Internal fertilization in animals is done through copulation. ***Copulation*** is when the semen is placed inside the body of the female by the male organ called the penis.

Internal fertilisation is a more certain method and are more likely to succeed because it occurs in a contained environment. There are not as many eggs needed.

External fertilisation

External fertilization which takes place outside the female body and are most common in vertebrates that live in water. The gametes of both the male and female are deposited into the water. External fertilisation is more likely not to succeed because they are exposed to predators and unstable environment. There are large numbers of eggs and sperms deposited.

Ovipary, vivipary and ovovivipary

The fertilised egg must be expelled from the female body. There are three ways that the egg can be expelled from the female body: ***ovipary, vivipary and ovovivipary***.

Ovipary

Oviparous animals are animals that lay eggs. The embryo develops inside the egg and is protected by the shell of the egg which forms after fertilisation. There are little or no embryonic development within the mother's body.

Vivipary

Viviparous animals are animals whose offspring are born alive. This means development of the embryo takes place inside the body of the mother, eventually leading to live birth. The mother provides nutrition to her offspring by way of the placenta.

Ovovivipary

Ovoviviparous animals are similar to viviparous species in that there is internal fertilization and their offspring are born live, but differ in that there is no placental connection and the embryo are nourished by egg yolk. The embryos develop inside eggs that are retained within the mother's body until they are ready to hatch.

Amniotic egg

Oviparous vertebrates have an amniotic egg and the embryo develops inside the egg. It is an airbreathing egg.

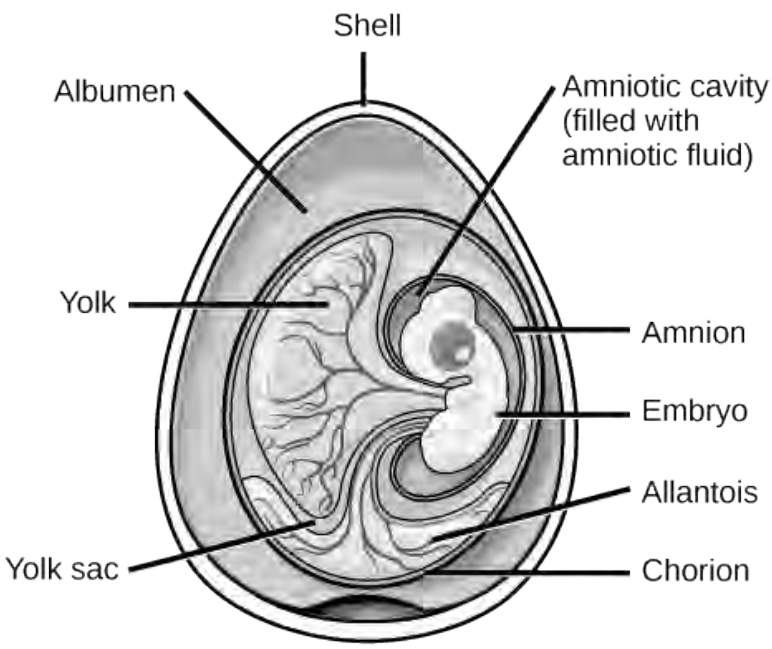
Components of the egg:

- The egg is protected by a leathery or calcareous ***shell***.
- ***Albumen*** (egg white) provides protein and water to the embryo.
- ***The yolk*** provides nutrients to the embryo.

The membranes in the amniotic egg:

- ***Chorion***: Encloses the embryo, yolk and other membranes. Facilitates gas exchange with exterior.
- ***Amnion***: Encloses the embryo.
- ***Allantois***: Receives nitrogenous waste products from embryo (including CO2) and facilitates gas exchange. It develops into the urinary bladder.
- ***Yolk sack***: Encloses the yolk mass and facilitates the transfer of water and nutrients to the embryo.

Together, these components manage the exchange of gasses, water, and nutrients between the embryo, yolk, albumen, and exterior.



OpenStax College, "Reptiles," OpenStax_CNX, April 10, 2013, http://cnx.org/content/m44689/1.4/.

Precocial and altricial development

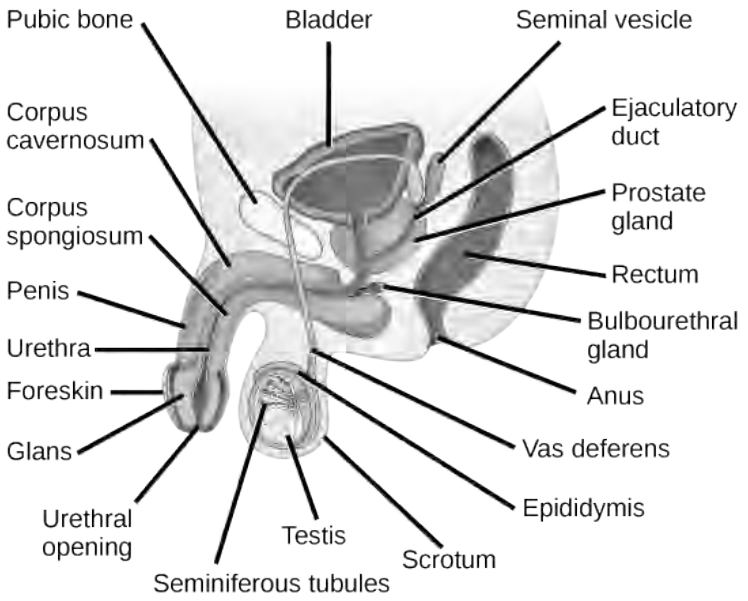
Precocial development refers to species in which the young are relatively mature and mobile from the moment of birth or hatching. They are able to walk, run or swim, their eyes are open.

Altricial development refers to a pattern of growth and development in organisms which are incapable of moving around on their own soon after hatching or being born. The young needs to be fed and taken care of for a long duration.

Human Reproduction

Structure of the male reproductive system

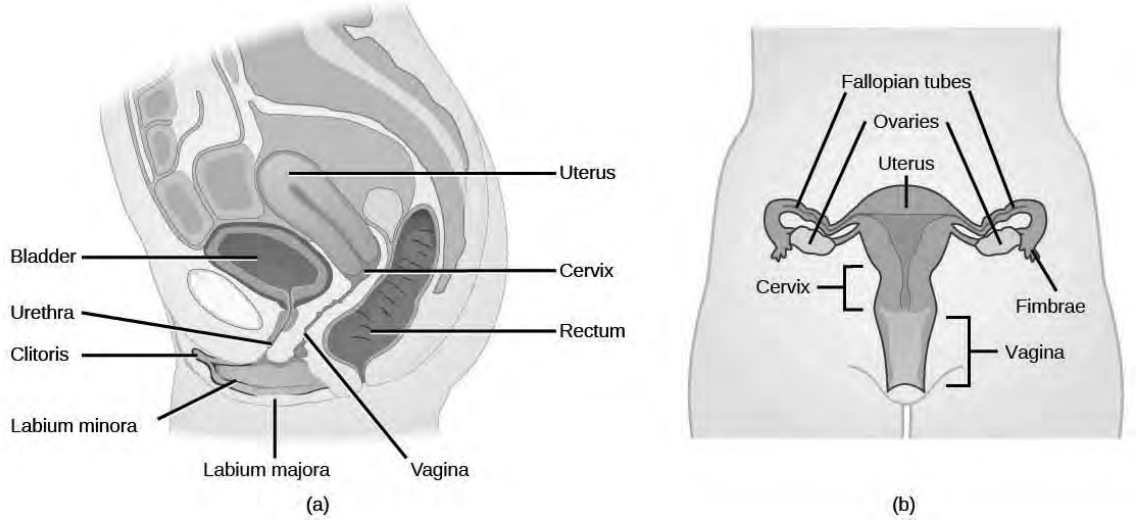
The function of the male reproductive system is to produce sperm and deliver them to the female.



OpenStax College, "Human Reproduction," OpenStax_CNX, June 28, 2013, http://cnx.org/content/m45549/1.4/.

Structure of the female reproductive system

The female reproductive system is designed to produce gametes and to nurture the growing embryo during pregnancy.



OpenStax College, "Human Reproduction," OpenStax_CNX, June 28, 2013, http://cnx.org/content/m45549/1.4/.

Puberty

Puberty is the time when the body undergo physical changes and becomes sexually mature. Girls start puberty at an earlier age than boys this is also the reason why girls are taller than boys during puberty.

UNIVERSITY OF THE FREE STATE

APPLICATIONS 2026

NOW OPEN

READY TO MAKE AN IMPACT?

Join a university that's dedicated to shaping the leaders of tomorrow. Whether you're drawn to the arts, sciences, law, health, or any of our diverse fields of study, UFS is where your potential can truly unfold.

WHY CHOOSE UFS?

Innovation and Excellence: Our dynamic academic programmes across ***seven faculties*** are designed to push the boundaries of knowledge and innovation.

Inclusivity and Diversity: UFS prides itself on creating a vibrant, inclusive community where every student is valued and supported.

World-Class Facilities: From cutting-edge laboratories to extensive libraries and sports facilities, our campuses are equipped to support your academic journey and personal growth.

Community and Belonging: At UFS, you're more than just a number. You're part of a family committed to kindness, respect, and character.

APPLICATION DETAILS:

Opening Date: Applications for all undergraduate programmes at the Bloemfontein and Qwaqwa campuses are open as of ***1 April, 2025***.

Closing Dates: Please note the specific closing dates for various faculties and programmes, detailed in our prospectus and on our website.

How to Apply: Visit ***apply.ufs.ac.za*** to start your application process. It's quick, easy, and free!

#ChooseUFS #FutureLeaders #ApplyNow #FutureFocused

SCAN ME

Don't miss your chance to be part of the UFS family in 2025. Apply now and take the first step toward a bright, impactful future. **For more details on our programmes, admission requirements, and how to apply, please visit our**

T: +27 51 401 9111 | E: info@ufs.ac.za | www.ufs.ac.za

Inspiring excellence, transforming lives through quality, impact, and care.

Kovsie 2B | VISION 130 Renew and Reimagine for 2034 | UNIVERSITY OF THE FREE STATE UNIVERSITEIT VAN DIE VRYSTAAT YUNIVESITHI YA FREISTATA | UFS STUDENT RECRUITMENT SERVICES

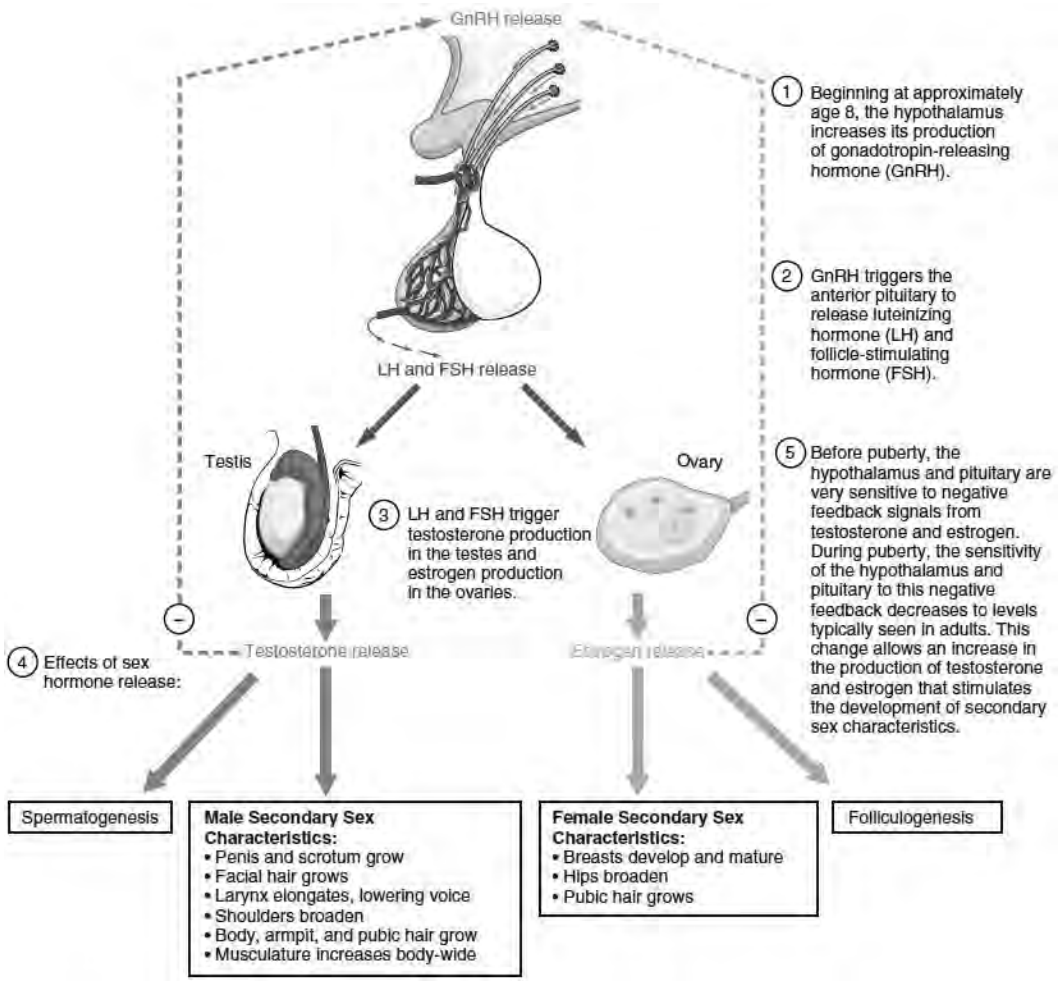
Hormones that control Puberty

The Hypothalamus in the brain, secrete the GnRH *(gonadotropin-releasing hormone)* that stimulates the Pituitary gland in the brain, to secrete FSH *(follicle-stimulating hormone)* and LH *(luteinising hormone)* into the blood that carries the hormones to the reproductive organs. FHS and LM stimulates the sex organs to produce hormones. In girls, the ovaries start secreting oestrogen and in boys the testes start secreting testosterone.

Body Changes during Puberty

Boys: Facial, pubic, underarm, leg and chest hair; the voice deepens; muscle develop; penis and testes get larger; testes start to produce sperm.

Girls: Breast development; widening of the hips; underarm and pubic hair; menstruation starts.



OpenStax College, "Development of the Male and Female Reproductive Systems," OpenStax_CNX, June 20, 2013, http://cnx.org/content/m46408/1.3/.

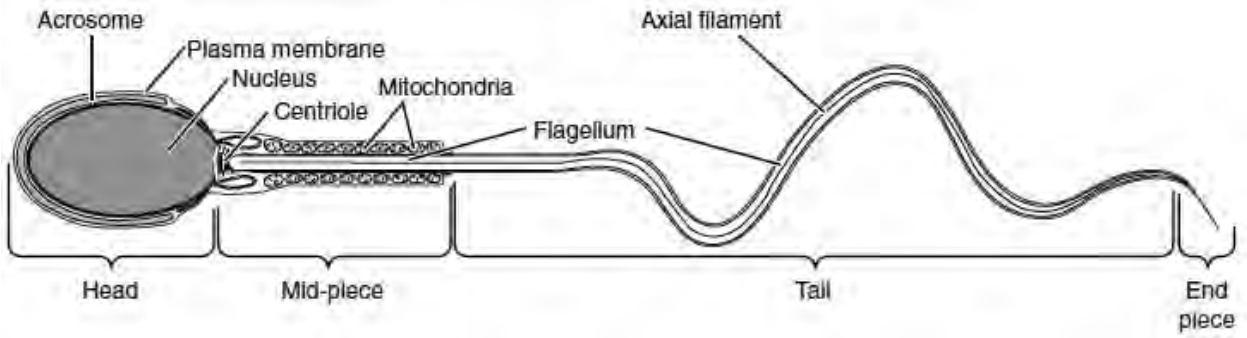
Gametogenesis

Spermatogenesis

The sperm production (*male gametes*) in males are called ***spermatogenesis*** and occurs in the seminiferous tubules of the testes.

When puberty is reached, the pituitary gland secrete FSH and LS. FSH stimulates the development of the *seminiferous tubules (coiled tubes in testes where sperms are formed)*. LH stimulates cells in the testes to secrete testosterone and spermatogenesis occur.

Structure of a sperm

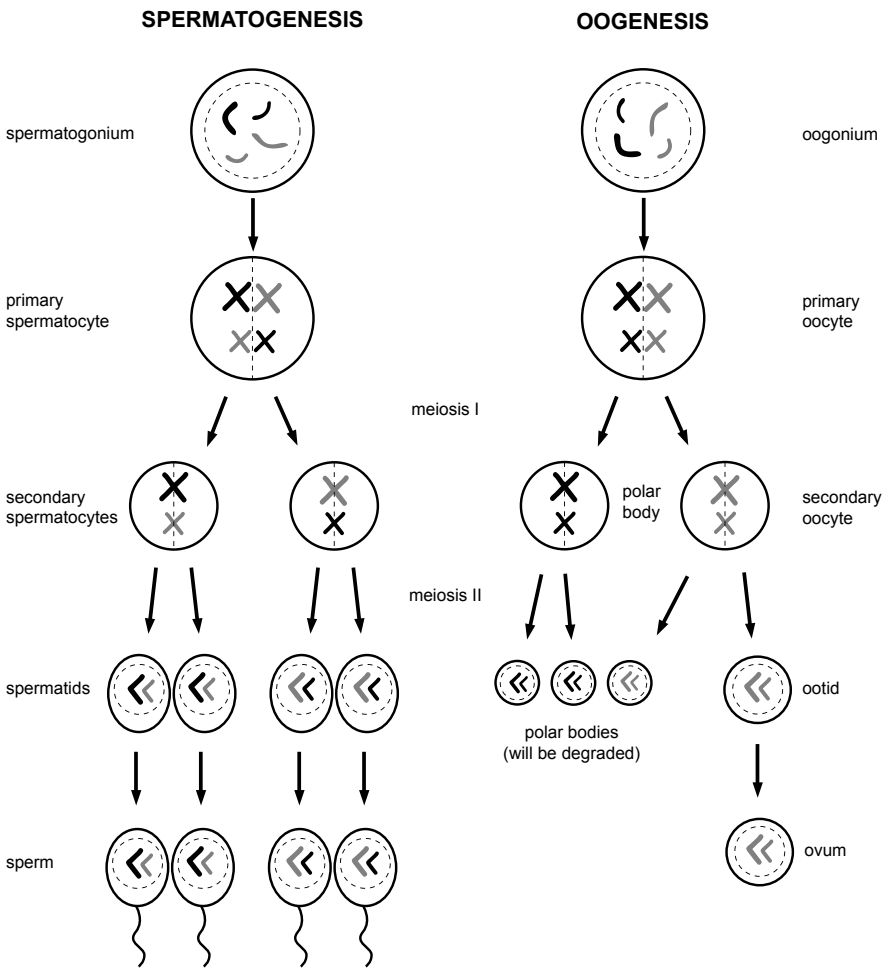


OpenStax College, "Anatomy and Physiology of the Male Reproductive System," OpenStax_CNX, June 20, 2013, http://cnx.org/content/m46400/1.3/.

Oogenesis

The ova production *(female gametes)* in females are called ***Oogenesis*** and occurs in the ovaries. The ovaries secrete the hormones progesterone and oestrogen, these hormones regulate the menstrual cycle and they also maintain a pregnancy.

When a girl is born her ovaries contains thousands of primary follicles and each primary follicles can produce an ovum. When puberty is reached, the pituitary gland secretes follicle, stimulating hormones FSH and LH. The FSH stimulates the development of primary follicle during the menstrual cycle.



WALTER SISULU UNIVERSITY

Study with us.

CHOOSE FROM OVER

170 PROGRAMMES

IN OUR **7 FACULTIES** SITUATED IN THE EASTERN CAPE

Applications open from 1 April 2024

Kindly note that applications close on 31 October 2024 for SA applicants, and closes on 30 September 2024 for international applicants.

visit **www.wsu.ac.za** to

Apply >>>

You may also scan QR Code

@WalterSisuluUni

www.wsu.ac.za

WSU
Walter Sisulu University
In pursuit of excellence

The Menstrual cycle

The menstrual cycle is the reproductive cycle of the female. One ovum is normally released from one of the ovaries every 28 days, a cycle can however be as short as 21 days or as long as 45 days. The menstrual cycle in 28 days:

Day 1 – 5
The primary follicle mature in the ovary. The uterine lining breaks down and passes through the vagina. The first day of bleeding is when the menstrual cycle starts.

Day 6 – 14
The uterine lining thickens again and prepare for implantation of a fertilised egg. On about day 14 the Graanfian follicle ruptures it release the ovum into the Fallopian tubes this is called ovulation. During ovulation the changes of becoming pregnant is higher. The remains of the Graanfian follicle develop into the corpus luteum.

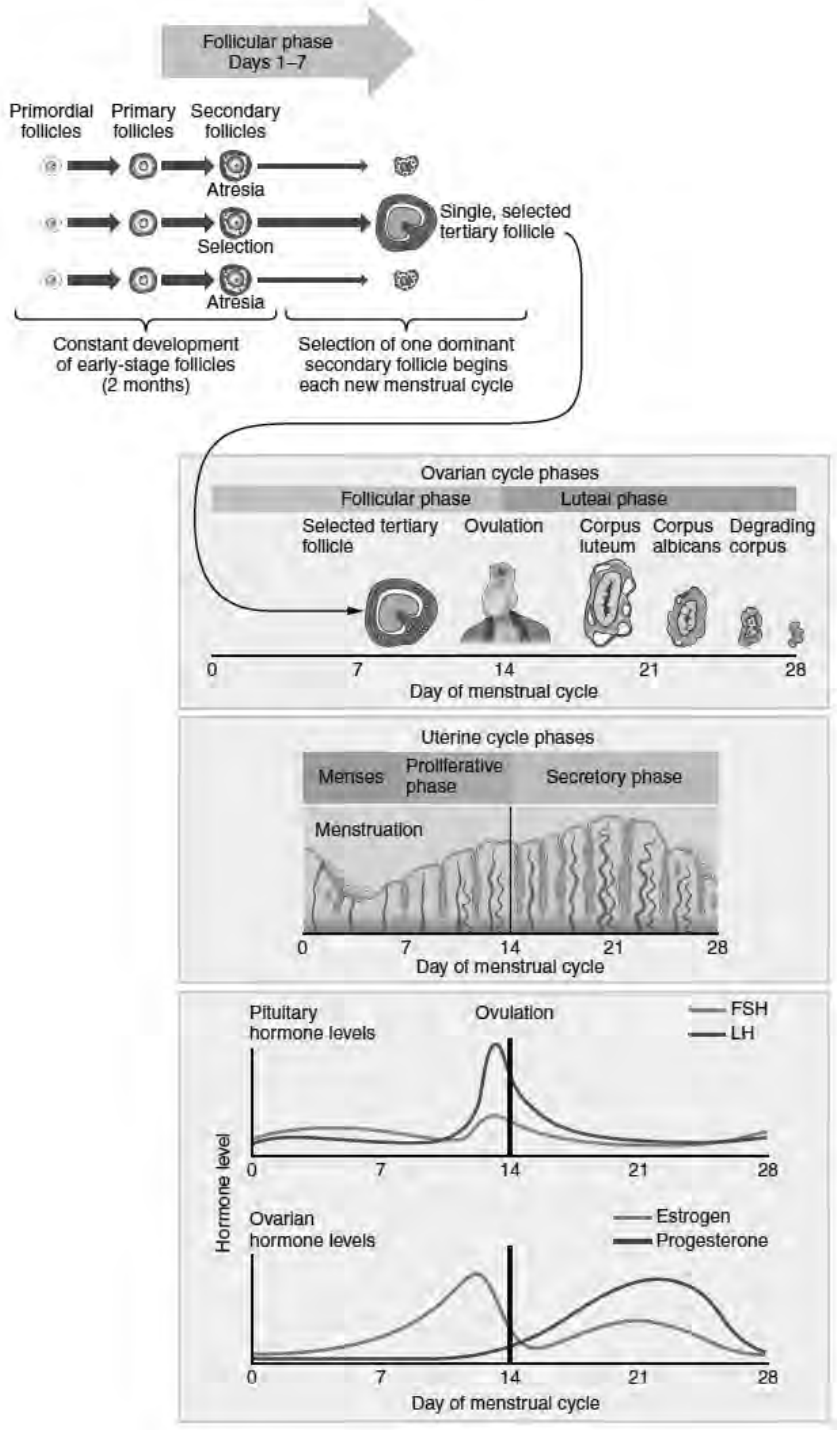
Day 15 – 28
The uterine lining continues to thicken as it is filled with more blood vessels and begins to secrete mucus and nutrients and is suitable for implantation of a fertilised ovum. If fertilisation does not occur, the corpus luteum degenerates. After this a new cycle will start.

Four Hormones that control the menstrual cycle

The Hypothalamus secretes *GnRH* (gonadotropin – releasing hormone) which stimulates the pituitary gland to secrete ***FSH*** (follicle stimulating hormones that stimulates a primary follicle to develop in one of the ovaries) and ***LH*** (luteinising hormone that stimulates the formation of the corous luteum and stimulates the release of the mature ovum).

The primary follicle divides by Meiosis I into a secondary follicle. The secondary follicle develops in the ovary, it secretes ***oestrogen***. Oestrogen stimulates the development of the uttering lining and the production of LH and inhibits production of FSH.

The corpus luteum that forms from the Graafian follicle secretes ***Progesterone***. Progesterone stimulates the development of the uterine endometrium after ovulation and also inhibits production of FSH and LH.



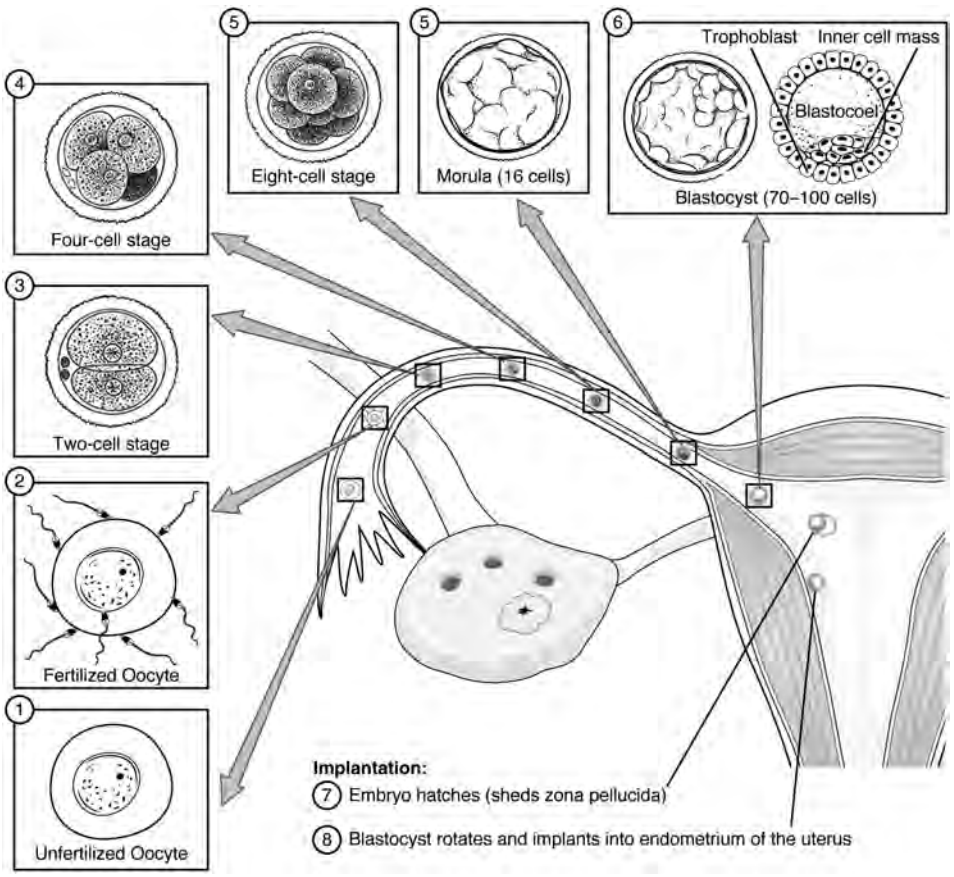
OpenStax College, "Anatomy and Physiology of the Female Reproductive System," OpenStax_CNX, June 20, 2013, http://cnx.org/content/m46392/1.3/.

Fertilisation and development of Zygote to blastocyst

Millions of sperm are transferred from the male penis into the vagina of the female, during sexual intercourse. The sperm swim up the cervix into the uterus and into the fallopian tubes. The ovum moves down the Fallopian tube, and is surrounded by sperm. The head of one sperm penetrates the ovum and release its haploid *(23 chromosomes)* nucleus to fuse with the ovum's haploid *(23 chromosomes)* nucleus. The two haloid nuclei fuse and produce a diploid zygote *(46 chromosomes)*

The ovum then creates a tough coating around the zygote which prevent other sperms from entering. The zygote divides by mitoses to produce a ***blastocyst*** *(a small hallow ball of cells)*. The blastocyst moves into the uterus and attached to the endometrium by growing ***villi*** *(finger-like structures)*. This happens about a week after fertilisation and is called implantation.

After implantation the corpus luteum continues to secrete progesterone to ensure that ovulation do not occur and to maintain the endometrium during pregnancy.



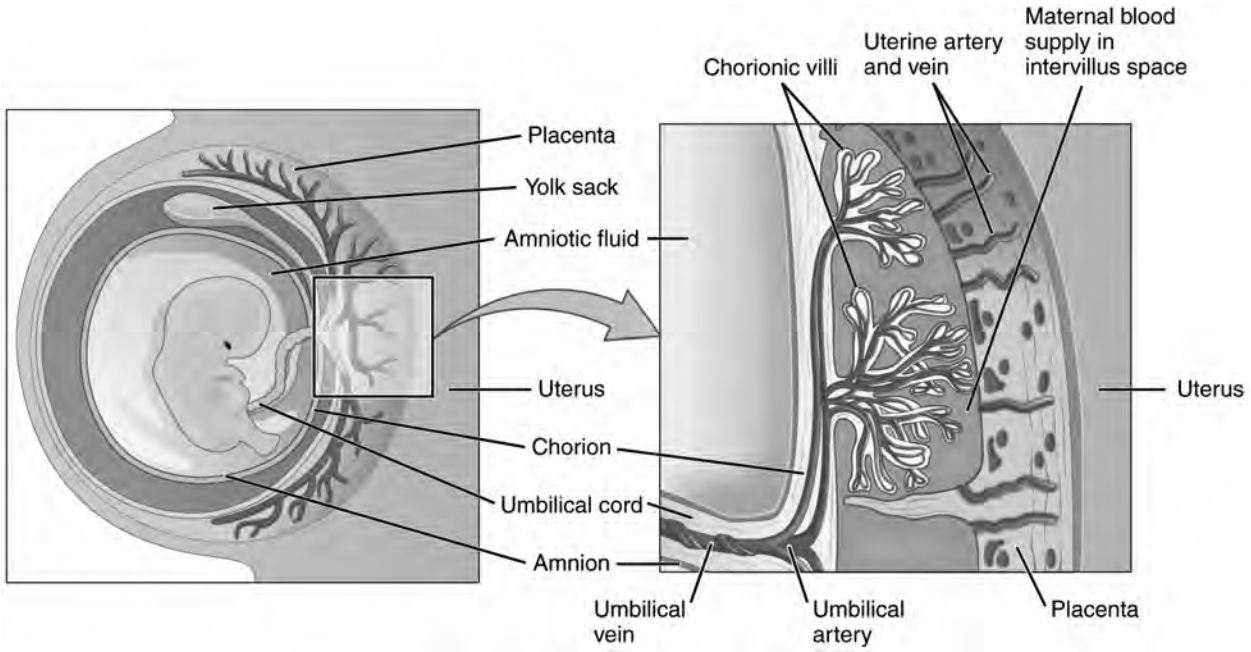
OpenStax College, "Embryonic Development," OpenStax_CNX, June 4, 2013, http://cnx.org/content/m46319/1.3/.

Development of the foetus

The implanted blastocyst is called an ***embryo***. The outer layer of cells of the blastocyst and the villi form the ***chorion***. Other cells of the blastocyst form an inner membrane and it is called the ***amnion***. The amnion fill with amniotic fluid. The amniotic fluid protects the foetus and allows the foetus to move freely.

The role of the placenta

The placenta is a disc-like structure that connects the foetus with the mother by an umbilical cord that have two arteries and one vain. The vain transport oxygenated blood from the placenta to the foetus. The Arteries transport deoxygenated blood and foetal waste to the placenta. The placenta secretes progesterone to prevent ovulation. The placenta supplies oxygen and nutrients to the foetus and also removes foetal waste.



OpenStax College, "Embryonic Development," OpenStax_CNX, June 4, 2013, http://cnx.org/content/m46319/1.3/.

3. Life at the molecular, Cellular and Tissue Level

Genetics and inheritance

Genetics and Genes

What is Genetics?

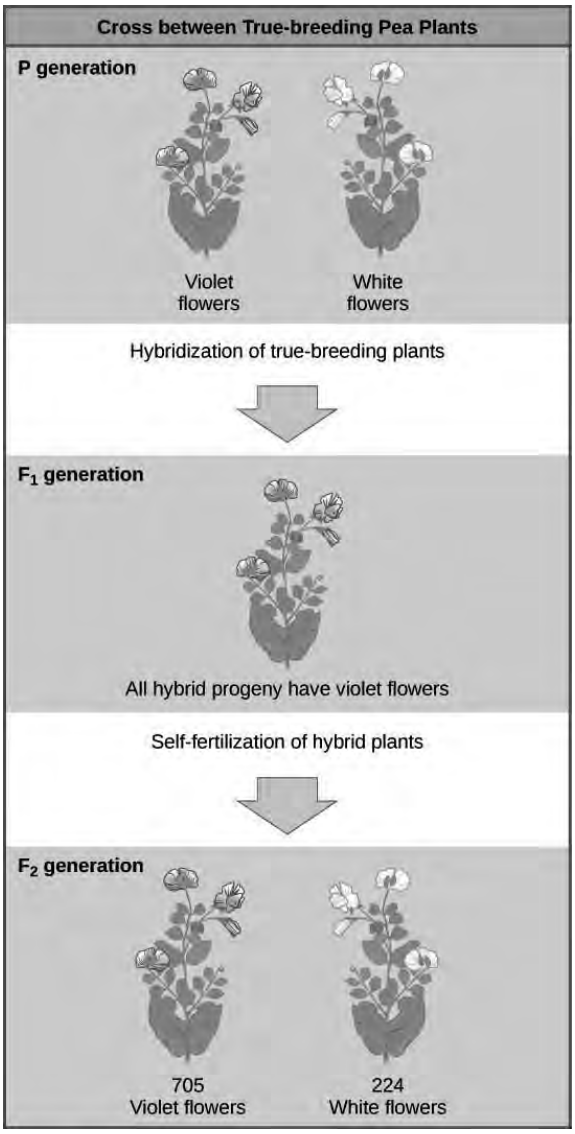
Genetics is the study of heredity, the biological process where parents passes certain genes onto their offspring. Every child inherits genes from their biological parents that express specific traits. Some of these trains may be physical for example eye colour or hair colour etc. Some genes may also carry certain risk of disorders and diseases.

Gregor Mendel (1822-1884): *"father of genetics"*

Johann Gregor Mendel (1822–1884) was a lifelong learner, teacher, scientist, and man of faith. As a young adult, he joined the Augustinian Abbey of St. Thomas in Brno in what is now the Czech Republic. Supported by the monastery, he taught physics, botany, and natural science courses at secondary and university levels. In 1856, he began a decade-long research pursuit involving inheritance patterns in honeybees and plants, ultimately settling on pea plants as his primary model system. In 1865, Mendel presented the results of his experiments with nearly 30,000 pea plants to the local Natural History Society. He demonstrated that traits are transmitted faithfully from parents to offspring independently of other traits and in dominant and recessive patterns. Mendel worked with traits that were inherited in distinct classes (specifically, violet versus white flowers); this is referred to as discontinuous variation. Mendel's choice of these kinds of traits allowed him to see experimentally that the traits were not blended in the offspring, nor were they absorbed, but rather that they kept their distinctness and could be passed on. In 1868, Mendel became abbot of the monastery and exchanged his scientific pursuits for his pastoral duties. He was not recognized for his extraordinary scientific contributions during his lifetime.

Mendel performed hybridizations, which involve mating two true-breeding individuals that have different traits. In one of his experiments on inheritance patterns, Mendel crossed plants that were true-breeding for violet flower colour with plants true-breeding for white flower colour (the P generation). The resulting hybrids in the F1 generation all had violet flowers. In the F2 generation,

approximately three quarters of the plants had violet flowers, and one quarter had white flowers. The diagram shows a cross between pea plants that are true-breeding for purple flower colour and plants true-breeding for white flower colour. This cross-fertilization of the P generation resulted in an F1 generation with all violet flowers. Self-fertilization of the F1 generation resulted in an F2 generation that consisted of 705 plants with violet flowers, and 224 plants with white flowers.



OpenStax College, "Mendel's Experiments and the Laws of Probability," OpenStax_CNX, July 8, 2013, http://cnx.org/content/m44476/1.6/.

Mendel reported the results of his crosses involving seven different characteristics, each with two contrasting traits. A ***trait*** is defined as a variation in the physical appearance of a heritable characteristic.

The characteristics included:

- plant height (tall and short plant): F1 generation were all tall, F2 generation 75% tall and 25% were short.
- seed colour (yellow and green): F1 generation were all yellow, F2 generation 75% yellow and 25% green.
- other characteristics were: flower colour (violet and white), pea pod colour (Green and yellow) and seed structure (round and wrinkled).

Mendel's laws of Heredity

1. The characteristics of an organism are passed on from one generation to another by genes.
2. The genes exist in pairs.
3. One of the genes comes from the father and one comes from the mother.
4. If a dominant and recessive gene of a trait exist together, the dominant form mask the recessive trait.
5. The recessive gene can be present even though it is not physically visible.

Dominant and recessive allele

A homologous pair of chromosomes, have the same number and sequence of genes. You inherit two genes for any characteristic, one from your father and one from you mother. These genes are found at the same position or locus on the homologous chromosomes and are known as ***alleles***.

The law of Segregation states that the characteristics of an organism are controlled by pairs of alleles which separate into different gametes as a result of meiosis and therefore only one allele of a trait is present in a gamete.

During fertilisation the gametes of two parents fuse and there will be two alleles of the trait. The segregating and recombination of alleles allows for genetic variation.

Alleles can be dominant or recessive. If two parents are crossed that each have alleles of a trait for example Parent one has identical alleles for purple flowers and parent 2 has identical alleles for white flowers, one of these traits may dominate (in this case the purple flower is dominant) and the off spring of the F1 generation will have purple flowers.

F1 generations will have a different genetic make-up as the parents, they will have a combination of the alleles for this gene. The off springs are ***hybrids*** because they have a combination of this traits. The hybrids will carry recessive alleles to the next generation.

Monohybrid crosses

Mendel carried out his experiments on pure-bred plants that varied since they had different forms of a single trait. This type of cross where only one trait (characteristic) is involve is called ***Mono-hybrid*** cross.

Complete dominance

The process of a Monohybrid crosses

1. Mendel crossed a ***homozygous*** (gametes have two copies of the same allele) plant that had two Tall alleles (TT) with a plant homozygous that had short alleles (tt).

   P generation
2. The two alleles in each plant separates when gametes were formed, one allele went into each gametes.

   F1 generation
3. The gametes fused to produce ***heterozygous*** (there are two different alleles, Tt) plants that were all tall because tall is dominant over short.
4. Mendel self-fertilised the F1 generations plants to produce

   F2 generation

   They appeared in a ratio 3:1 of tall to short.

Punnett squares

Scientists have devised a shorter method called Punnet squares to show crosses.

Draw Punnet squares:

- Choose a letter to represent each characteristic.
- The capital letter represents the dominant form of the trait and the lower-case letter represents the recessive form.
- Write the **genotypes** (the combination of the alleles) and the **phenotypes** (physical characteristic) above the grid.
- Place the gametes from one parent in the top row and the other parent on the left-hand column.
- Place the results crosses in the central boxes.
- Always write the dominant allele first.

Let T represent the allele of tall plants and t represent the allele for short plants

Parent Generation

Phenotype tall x short
Genotype TT X tt

F1 Generation – All plants will be tall

Gametes	T	T
T	Tt	Tt
T	Tt	Tt

Tt (genotype) = Tall (phenotype)

F2 Generation – 3 tall plants and 1 short

Gametes	T	t
T	TT	Tt
t	Tt	tt

TT(genotype) = tall (phenotype)
Tt (genotype) = tall (phenotype)
tt (genotype) = short (phenotype)

The inheritance pattern shown in Mendel's monohybrid crosses of short and tall plants is called ***complete dominance***. The tall allele is dominant over the short allele and masks the short characteristic.

Incomplete dominance

Some alleles show incomplete or partial dominance, where the offspring show a blend of both the parents' phenotypes. An example when a red snapdragon are crossed with a white snapdragon, all the off spring will have pink flowers, the red trait is partially dominant over the white trait. Another example is wavy, curly or straight hair. Wavy hair is a mixture between curly and straight hair. A Punnet square could be used to show the cross if both the parents have wavy hair.

	W	S
W	WW	WS
S	WS	SS

The phenotypic ratio: 1 curly hair: 2 wavy hair: 1 straight hair
The genotypic ratio: 1WW: 2WS: 1SS

Both alleles are represented with capitals, this indicates that neither allele is dominant over the other.

Co-dominance

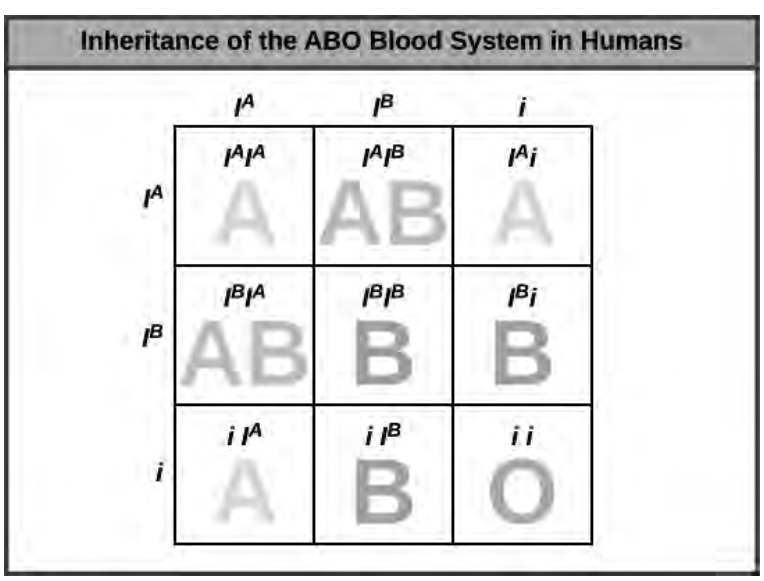
In some cases both of the alleles are equally dominant and the phenotype is not a blend of traits but the traits for both are seen in the offspring. An example is if a pure-bred red coat bull mates with a pure-bred cow with a white coat, the calves will have coats with patches of red and white. This is because the alleles for a red and a white coat are co-dominant.

Blood groups

In humans there are three alleles that determine the blood type of a person: I^A, I^B and i. The alleles I^A and I^B show co-dominance and the i alleles is recessive. ***Multiple alleles*** is when there are three or more variants of a gene that codes for a certain characteristic, as in the example of blood types. Only two of the three alleles can be present in a genotype.

There are four common blood groups: A, B, AB and O. The antigens that you possess determine your blood type. A person with blood type A has antigen A, a person with a blood type B has antigen B. A person with a blood type AB will have both antigen A and B. Antigen A and B are co-dominant. Blood type O have neither A nor B antigens.

Phenotype A = Genotype $I^A I^A$ or $I^A I^O$
Phenotype B = Genotype $I^B I^B$ or $I^B I^O$
Phenotype AB = Genotype $I^A I^B$
Phenotype O = $I^O I^O$



OpenStax College, "Extensions of the Laws of Inheritance," OpenStax_CNX, June 28, 2013, http://cnx.org/content/m45471/1.5/.

Dihybrid crosses

Dihybrid crosses are crosses in which the inheritance of two pairs of contrasting characteristics is considered. Mendel also examined the inheritance of two different traits

Mendel crossed a tall pure-bred pea plant (TT) with purple flowers (PP), with a short pure-bred pea plant (tt) with white flowers (pp)

T represents the allele for tall plants (dominant).
t represents the allele for short plants (recessive).
P represents the allele for purple flowers (dominant).
p represents the allele for white flowers (recessive).

Parent generation:

TTPP X ttpp

F1 Generation: All the offspring was Tall plants with purple flowers
TtPp

F2 Generation:

	TP	**Tp**	**tP**	**tp**
TP	TTPP	TTPp	TtPP	TtPp
Tp	TTPp	TTpp	TtPp	Ttpp
tP	TtPP	TtPp	ttPP	ttPp
tp	TtPp	Ttpp	ttPp	ttpp

Resulting Phenotypes: 9 Tall with purple flowers: 3 Tall with white flowers: 3 short with purple flowers: 1 short with white flower (9:3:3:1)

Mendel concluded that the gene for one trait does not influence the inheritance of the gene for another trait. Based on this he formulates his ***Law of Independent Assortment.***

Sex chromosomes

We know that there are 23 pairs of chromosomes in the normal human karyotype. Chromosomes 1 to 22 are called autosomes. The 23rd pair consist of the sex chromosome. The sex chromosome determine your sex. The sex chromosomes in females consists of two X chromosomes, and in males the sex chromosomes consists of one X and one Y chromosome.

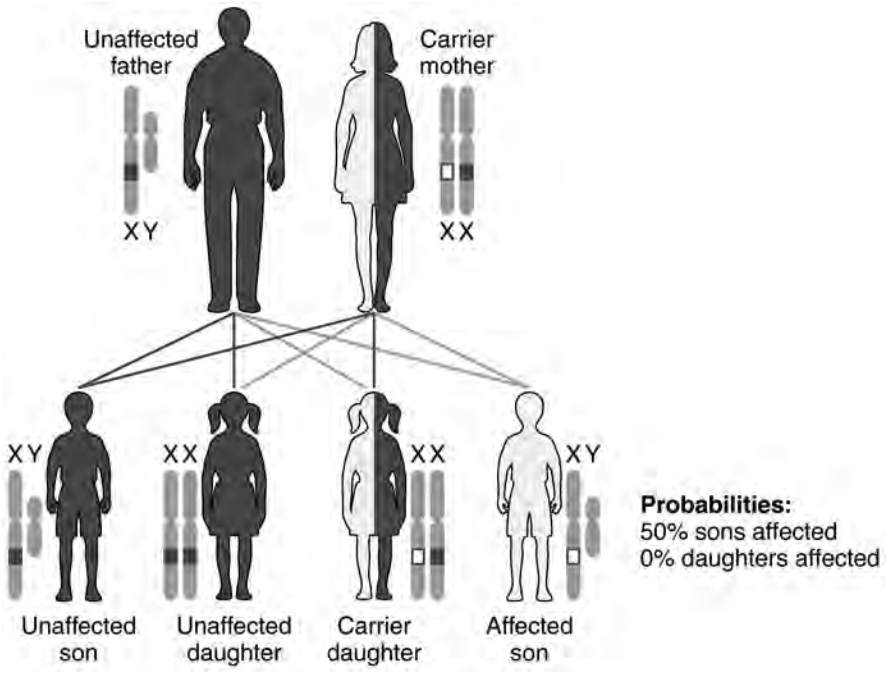
The symbols XX are used for the female chromosomes and the symbol XY are used for the male sex chromosome.

X-linked traits

Most sex-link disorders involve the X chromosome and occur more frequently in males than in females. A female will need both her X chromosomes to carry the recessive allele for her to suffer from these diseases

An Example of disorders include colour blindness and haemophilia. This means that only male will suffer from these diseases. The female has a normal gene masking the mutant one, because

the normal gene is the dominant gene and the mutation is the recessive gene. The X-linked gene showed up in the males while the females are only carries for the disease.



OpenStax College, "Patterns of Inheritance," OpenStax_CNX, June 4, 2013, http://cnx.org/content/m46311/1.3/.

Y-linked traits

Almost all sex-linked alleles and disorders are X-linked. The Y chromosome only carries a few genes and one of the reasons for this is because the Y chromosome is much smaller than the X chromosome. Most of the genes of the Y chromosome have to do with male sexual functioning. Y-linked traits are passed from fathers to sons.

Mutations

Mutation is a permanent change in the DNA of an organism. Mutation can occur on a large scale (Chromosomal mutation) or on a small scale (Gene mutation).

Chromosomal mutation

Chromosomal mutations are changes in either the chromosome structure or number of chromosomes in the cell. This can result in chromosomes being deleted or added or being broken up or rearranged.

Types of chromosomal mutation

- Duplication: the chromosome will have two copies of the same gene.
- Deletion: a portion of the chromosome breaks off during meiosis and the genes are lost.
- Intervention: a portion of the gene breaks off and turns upside down and reattaches.
- Translocation: a portion of one chromosome is transferred to another chromosome.

Gene mutation

Mutation may cause changes in genes. Most of these mutations occur as a result of mistakes during DNA replication.

Types of gene mutation

- **Substitution:** when one base in the DNA strand is replaced by a different one .
- **Insertion:** one or more bases are added to the DNA strand.
- **Deletion:** one or more bases are deleted from the DNA strand.
- **Inversion:** the order of the bases is swapped around.

Harmless mutation

Harmless mutations are harmless in a particular set of environmental condition, and do not increase or decrease the change of survival of the organism. Examples are: red hair, freckles, blue eyes and baldness.

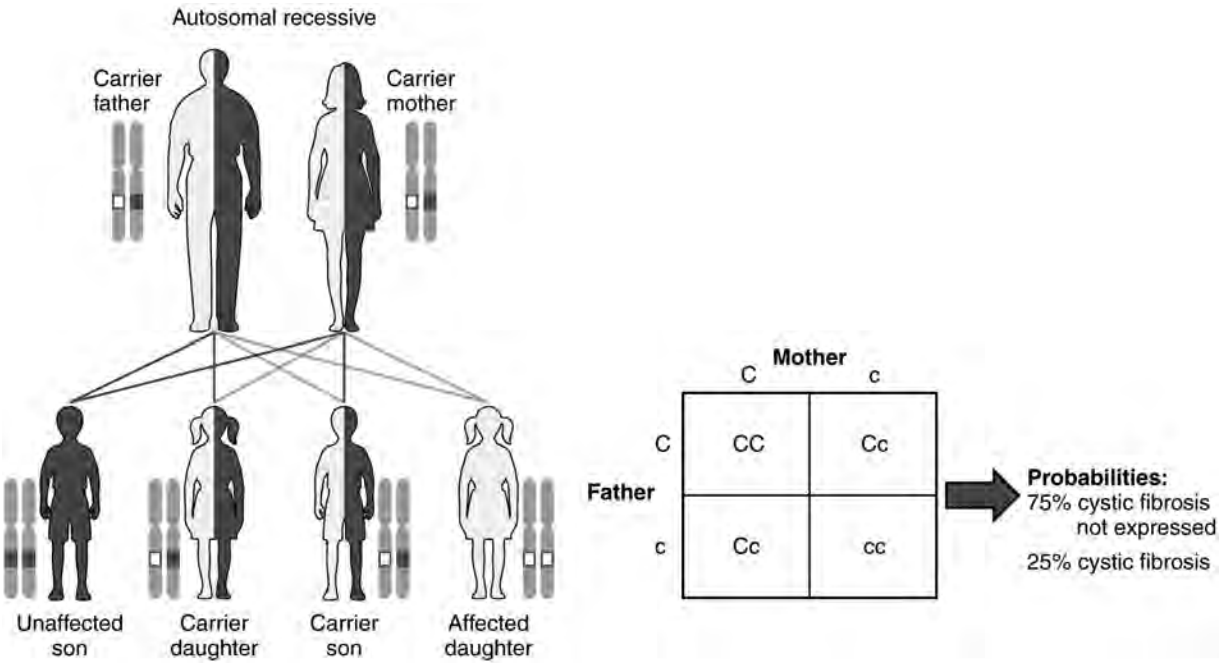
Harmful mutation

Harmful mutation decrease the chances of survival of the organism.
Examples are: albinism, Down syndrome, cystic fibrosis, haemophilia and Klinefelter syndrome

Genetic disorders

A genetic disorder is a condition that is inherited and it results in a disturbance of the normal functioning of the body of an organism. Gene mutation and chromosome mutation may result in an organism having a genetic disorder.

Cystic fibroses is a genetic disorder.



OpenStax College, "Patterns of Inheritance," OpenStax_CNX, June 4, 2013, http://cnx.org/content/m46311/1.3/.

Genetic Engineering

Genetic engineering is the process of changing the DNA of an organism with the intention of improvement to the organism.

It involves the removing a gene from the cell of one organism (the donor) and transferring it into the cell of another organism (the recipient). Once the recipient has received the gene from the donor, it is called a Genetic Modified Organism (GMO).

Genetic modified organism in agriculture

Crop plants have been genetically modified to:

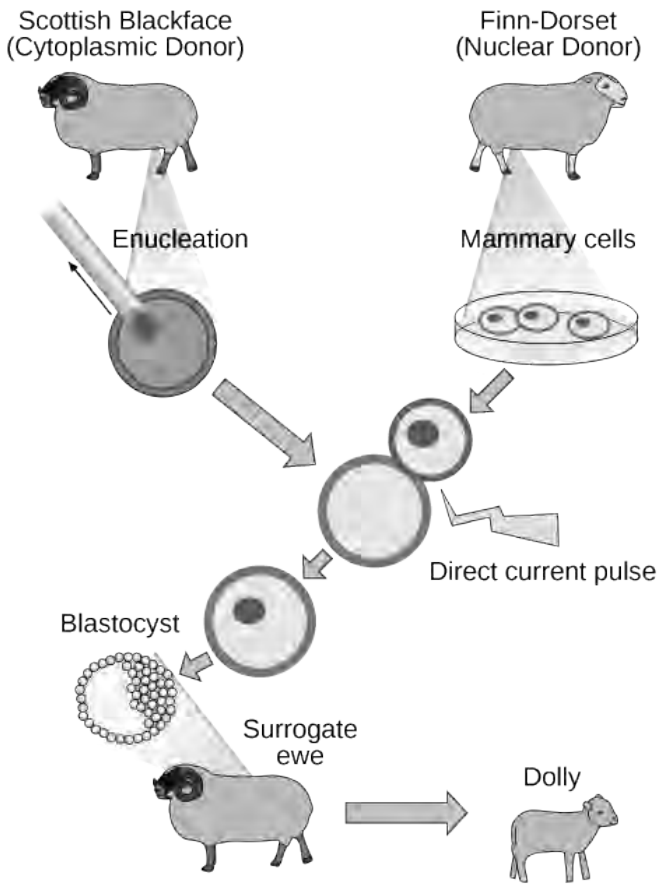
- Improve their nutritional content.
- Provide resistance to pests.
- Provide resistance to herbicides.
- Increase the shelf life.
- Provide more food.

Cloning

In medical biotechnology there are two types of cloning, ***reproductive cloning and therapeutic cloning.***

Reproductive cloning

Reproductive cloning is the production of a genetically identical copy of a specific organism. The most well-known clone was a sheep named Dolly. This was the first mammal cloned from an adult cell.



OpenStax College, "Cloning and Genetic Engineering," OpenStax_CNX, March 21, 2013, http://cnx.org/content/m45482/1.3/.

1. A body cell is removed from the donor sheep and the nucleus is removed.
2. The nucleus of an egg cell from another sheep is removed and thrown away.
3. The body cell nucleus is inserted into the egg cell using an electric shock.
4. The embryo is cultured.
5. The embryo is implanted into the uterus of a surrogate mother.
6. Dolly is born and is identical to the nucleus donor.

Therapeutic cloning

Certain cells in the human body can develop into many different kinds of cells these cells are called ***stem cells***. Stem cell can be used to replace or repair damaged tissues or organs. Stem cells are found in the membranes surrounding an embryo, the umbilical cord and several areas of the adult body such as bone marrow. Stem cells are stored in stem cell banks, parents can store their baby's umbilical cords in these banks. The stem cells can be used to cure later illnesses.

Using human DNA

Paternity testing

Special techniques can be used to determine who the biological father or mother of a child is. Samples are taken form the mother, child and claimed father. Half of the DNA in a cell is inherited from the mother and the other half from the father. By comparing the child DNA with that of the mother, it can be determine what part of the DNA is inherited from the mother and the remaining DNA will come from the father. If the DNA of the claimed father coincides with the established profile, it is possible that he is the biological father.

DNA is quite a stable molecule and it degenerates very slowly. We can extract DNA from skeletons who died long ago and find out who they were by comparing the DNA with possible close relatives.

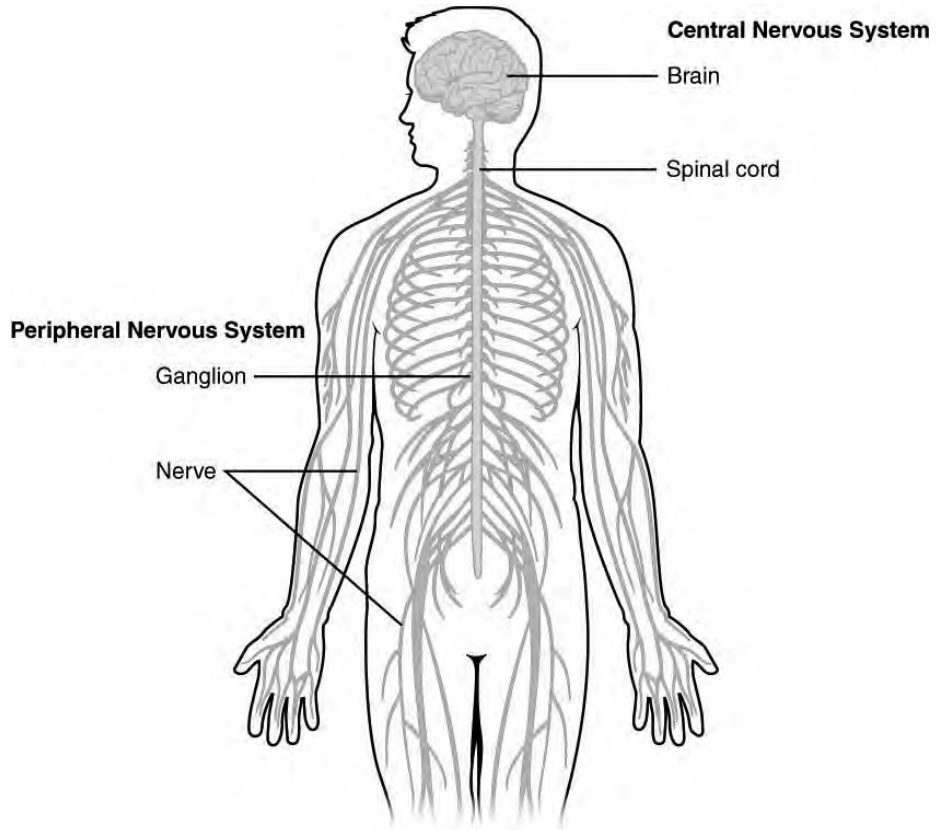
DNA Fingerprinting and Forensics

Every human being, except identical twins, has a unique genetic profile or DNA fingerprint. This can is very useful for forensic Scientists. Cells in the form of blood, saliva, semen, hair or tissue samples, which are collected from a crime scene can be used to produce DNA profiles. Someone with a DNA profile that matches the DNA profile from the crime scene can therefore be placed at the crime scene.

4. Life at Molecular, Cellular and Tissue level

Responding to the environment: Human Nervous system

The human body has two systems, the nervous and endocrine system, that enable it to respond to the environment. The nervous system uses rapid reaction to control the body's response to internal and external stimuli. Impulses are sent along nerves to activate glands or muscles.
The nervous system is divided into the ***Peripheral nervous system (PNS)*** and the ***central nervous system (CNS)***. The ***CNS*** consist of the spinal cord and the brain. The ***PNS*** consist of the cranial nerves that branch from the brain and the spinal nerves that branch from the spinal cord.



OpenStax College, "Basic Structure and Function of the Nervous System," OpenStax_CNX, June 28, 2013, http://cnx.org/content/m46500/1.6/.

Typical nervous response

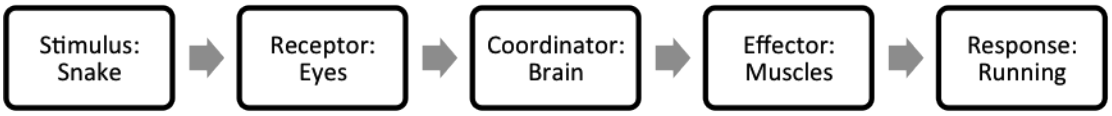
Stimulus: External something you see, hear, feel, smell, taste or internal like body temperature.

Receptors: Organs or cells that detect stimuli example; eyes, nose, tongue and skin.

Coordinators: The spinal cord and brain receive information through nerve impulses from the receptors.

Effectors: Glands and muscles respond to the nerve impulses and respond.

Response: Secretion and movement is a response to the stimulus.

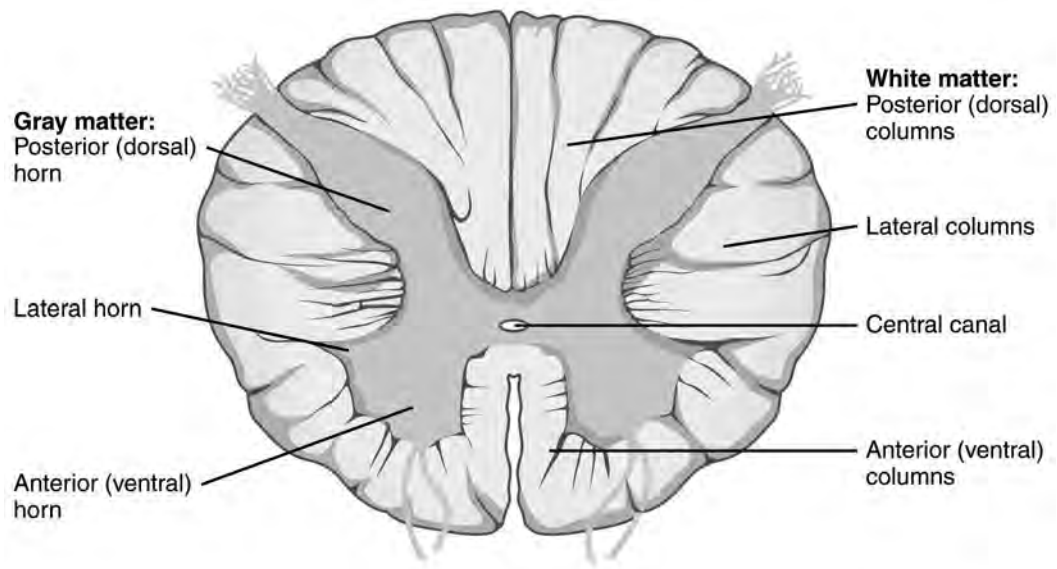


Central nervous system (CNS)

The Brain

Part of the Brain	Function
Cerebrum	Origin and control of all voluntary movements; Control higher mental activities; Perception and sensation; seat of emotions
Mid-brain	Connects the cerebral cortex with the pons carolii and cerebellum
Pons Varolii	Connects cerebrum visual, auditory and motor areas of the cerebrum with the cerebellum; Connects the two hemispheres of the cerebellum; Conducts impulses from medulla oblongata to cerebrum.
Cerebellum	Co-ordinates the action of all voluntary muscles to bring about controlled movement; Control muscle tonus and balance
Medulla oblongata	Controls all involuntary actions e.g. respiration, heartbeat, salivation, peristalsis, blood vessel dilation and constriction, sleep etc.; Conducts impulses to and from the spinal cord and the brain; Allows for crossing over nerves between spinal cord and brain
Thalamus	Is a relay centre for all incoming sensory impulses to the appropriate part of the cerebral cortex; Regulates and co-ordinates the external manifestation of certain emotion
Hypothalamus	Reflex control centre of control mechanisms e.g. hunger, thirst, body temperature, carbohydrate and fat metabolism, sleep, water balance, blood pressure and emotions; Controls the secretion of the adenohypophysis

The Spinal cord



OpenStax College, "The Central Nervous System," OpenStax_CNX, June 28, 2013, http://cnx.org/content/m46533/1.4/.

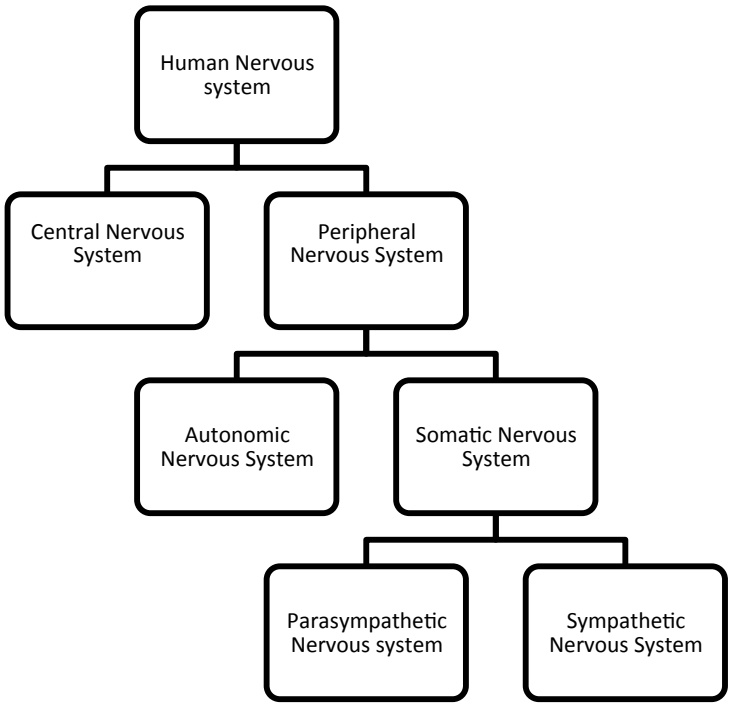
Peripheral nervous system (PNS)

The PNS includes all the nerves that are not part of the spinal cord or brain. The PNS transmits impulses from the body to the CNS *(Central Nervous System)* and from the CNS to the body.

The PNS forms two nervous systems namely the ***somatic nervous system*** (receives information form sensory organs and the brain and responds by skeletal muscle to relax or contract) and ***the Autonomic nervous system*** (controls involuntary reactions)

The Autonomic nervous system consist of the ***Sympathetic nervous system*** (prepare the body for stress or emergencies) and the ***Parasympathetic nervous system*** (when at rest).

The Sympathetic nervous system and the Parasympathetic nervous system work ***antagonistically*** (work against each other).



Structure and function of the nervous tissue

Nervous tissue consist of neurons and neuroglial cells. Neuroglial cells provide nutritions to the neurons and are found mostly in the CNS *(Central Nervous System)*.

There are three types of neurons:

Sensory neurons: they carry impulses from receptors to the interneurons in the CNS *(Central Nervous System)*

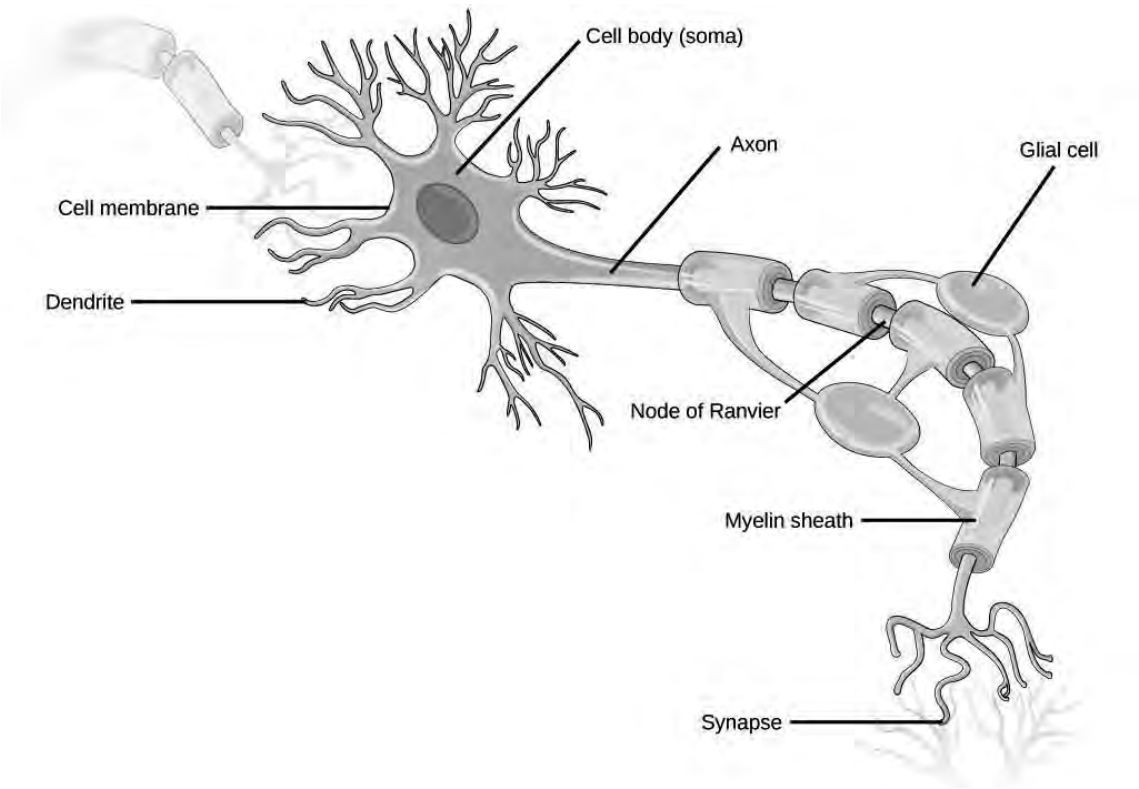
- Interneurons: they are found in the CNS; they relay the impulses form the sensory neurons to the motor neurons.
- Motor neurons: they transmit impulses from the interneurons in the CNS to the effectors.

Structure of the neuron:

The neuron have a cell body, dendrites and one or more axons. The axons are surrounded by a fatty non-cellular myelin sheath and concentric layers of Schwann cells (Neurilemma).
Neurilemma and myelin sheath from nodes of Ranvier along the axons. They also provide electrical insulation and speeds up the transmission of impulses.

Structurally neurons are grouped as follows:

- Unipolar: single process leaving the cell body then divides into axon and dendrite.
- Multipolar: an axon and many dendrites leave the cell body.
- Bipolar: only one dendrite at one end and an axon at the order end leave the cell body.



OpenStax College, "Nervous System," OpenStax_CNX, April 8, 2013, http://cnx.org/content/m45539/1.2/.

Connection between neurons occur at a synapse, where the terminal branches of an axon of one neuron and the dendrites or cell body of the adjacent neuron lie in close proximity to each other but there is no direct contact.

A nerve impulse is an electro-chemical disturbance that passes along a nerve fibre. The triggering of an impulse follows an "all- or non- principal". Conduction of an impulse across a synaptic space is a chemical process (acetylcholine).

Effects of drugs on nervous system

A drug is defined as a natural or man-made substance that is legal or illegal. Some drugs can affect the Central Nervous System. Drugs can be classified into three categories *(some drugs fit into more than one category):*

- Stimulants *(uppers)*: increase the activity of the Central Nervous System and body functions.
- Depressant *(downers)*: slow down the activities of the nervous system and body function.
- Hallucinogens: cause perceptual distortions and hallucinations.

Drugs effect the working and secretion of neurotransmitters in the brain. Neurotransmitters are chemical substances that transmit electrical nerve impulses between two neurons at synapses. ***Serotonin*** (influence appetite, mood, sleep and dreaming) and ***dopamine*** (links with feelings of happiness and pleasure) are the two neurotransmitters that are affected the most by drugs.

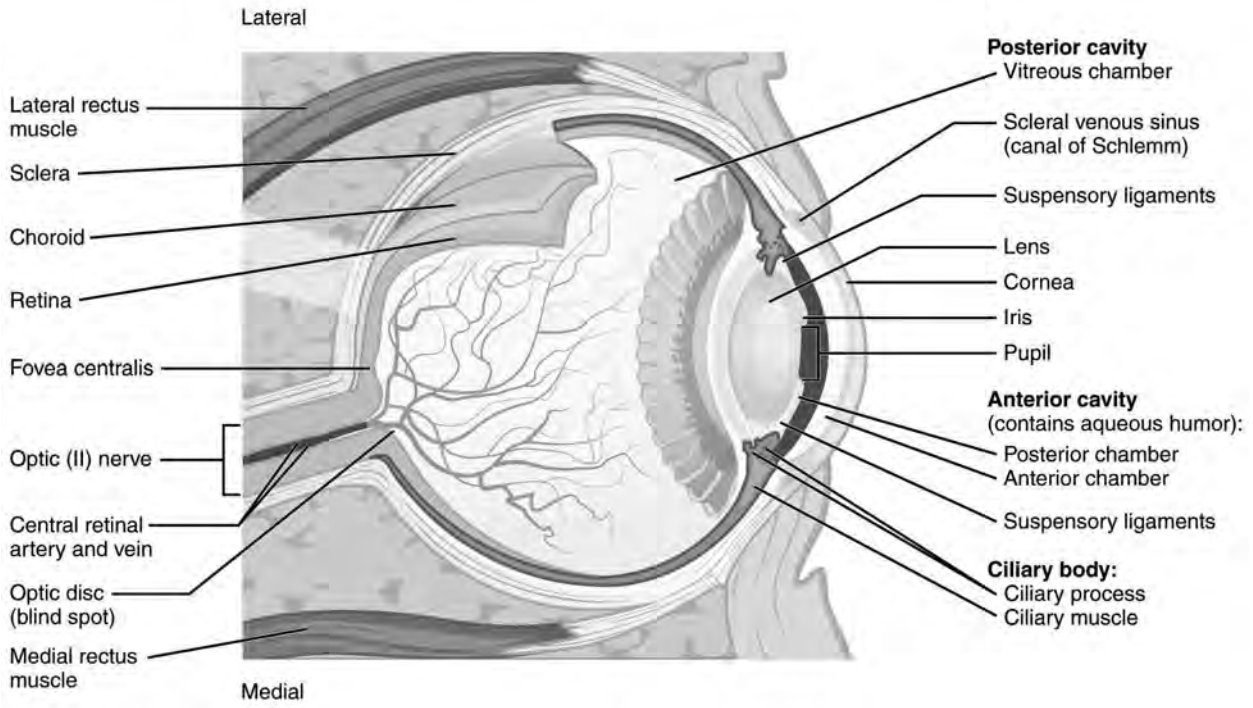
Drug name (Street name)	Effect on the nervous system	Some of the Side effects
Nicotine – Legal (Cigarettes; Tobacco)	It reach the brain 8 seconds after inhalation It increase the level of Dopamine	It is the most addictive substance; Coronary heart disease; High cholesterol; Cancer of the kidney, urinary, bladder, mouth, lungs, pancreas; Chronic bronchitis; Emphysema; Pneumonia; Peptic ulcers Chronic bowel disease; Tooth decay; Gum disease; Osteoporosis; Cataracts; Thyroid disease
Marijuana – illegal (Dagga; grass; weed)	The active ingredient is THC that binds to sites in the brain called cannabinoid receptors, thereby preventing anan-damide, the normal chemical, from doing so	Attention deficit and learning disabilities; cancer; memory loss; depression; brain abnormalities; schizophrenia; personality and mood changes; suppression of the immune system
Methamphetamine - illegal (Meth; Tik; Ice; globes)	It increase the levels of dopamine It has a neurotoxic effect on the brain cells and damage the cells that secrete dopamine and serotonin	Depression; suicide; heart disease; psychosis and violent behaviour; severe rotting of teeth; weight loss; facial sores; Brain damage; death
Alcohol – legal (Booze; dop)	Slows down the function of the nervous system Increase dopamine levels	Slow reflexes; cancer; Loss of inhibitions; toxic overdose can cause coma or death
Ecstasy – illegal (E; XTC;)	Increase the serotonin levels which over time damages the serotonin secreting neurons which cause severe depres-sion	False sense of affection; tremors; paranoia; teeth clenching; depres-sion; anxiety; possible brain damage; death
Heroin – illegal (Thai; Smack; H)	Depress the CNS by slowing down the transmission of nerve impulses in the sensory pathways of the brain and spinal cord. It enters the brain very quickly and turns to morphine. It also inhibits the brain centre that control coughing and breathing.	Highly addictive; damage the all major body systems including the brain; depression; bad teeth; insomnia; respiratory illnesses; muscular weakness and partial paralysis; death; Only 1% of all herion addicts recover
Cocaine – illegal (Coke; Crack; Candy)	Increase the time that dopamine remains in the synapse.	Highly addictive; stays in the body for up to 5 years; seizures; aggres-sion; anxiety; heart kidney and brain damage; paranoia; restlessness; nausea; insomnia; weight loss; death

Sensory Receptors

A **sensory receptor** is a sensory nerve ending that responds to a stimulus in the internal or external environment of an organism. Examples of sensory stimulus are touch, pressure, pain, light, sound, position in space, and vibration.

Structure of the eye

The eye is the sense organ for sight and contains photoreceptors. Six external eye muscles keep the eye in position and control eye movement.



OpenStax College, "Sensory Perception," OpenStax_CNX, June 28, 2013, http://cnx.org/content/m46577/1.4/.

Functioning of the eye

Light rays are reflected by an object, enters the eye through the transparent conjunctiva and cornea. The curved surface of the cornea, the lens and the humours, bent the light rays so that it falls on the retina and a smaller and upside down image forms. The rods and cones (light sensitive receptor cells) are stimulated and an electrical impulse is generated. The impulse is transmitted to the optic nerves, the optic nerves of both eyes cross at the optic chiasm at the base of the brain. The impulses are transmitted to the visual cortex in the brain where the message is interpreted. The brain reverse the upside down image so that it is seen upright.

Binocular Vision

Binocular vision is vision in which both eyes are used together. With combination of the information of both eyes the brain can form a 3D image. Binocular vision gives us better depth perception and a wider field of vision.

Accommodation of the eye

Your eyes are at rest when viewing objects within a range of 6 metres. Any object further or closer requires adjustment of the curvature of the lens.

If an object is further than 6 metres, the curvature of the lens must decrease to create longer focal length. The ciliary muscle relax and the suspensory ligaments become tight and pulls the lens causing it to become convex (longer and flatter) and its refractory power decrease.

If an object is closer than 6 meters, the curvature of the lens must increase to create a shorter focal length. The ciliary muscle contract and the suspensory ligaments relax causing the lens to become more convex (rounder) and its refractory power increase.

Eye disorders

Eye disorder	Description	Treatment
Cataracts	The protein in the lens starts to clump together, causing areas of the lens to become cloudy and scatter the light that enters the eye	Surgery, Remove the clouded lens and replaces it with artificial intraocular lens
Cornea transplant	When the cornea is damaged due to injury or disease it distort the light and cause blurred vision	Surgery, damaged tissue replaced using tissue donated from the eye bank
Astigmatism	Both near and distant images on retina blurred due to irregular curvature of the cornea	Prescribed glasses; Contact lenses; Laser surgery
Myopia (Short-sighted)	Can focus on object close but not far away. The eyeball is too long resulting in light rays being brought into focus in front of the retina	Wearing Concave lenses that moves the focus point of the image back onto the retina
Hyperopia (Far-sighted)	Can see objects far away but cannot focus on those nearby. The eyeball is too short resulting in light rays being brought into focus behind the retina	Wearing convex lenses that bend light that the focus point Of the image is brought forward onto the retina

Structure and functioning of the ear

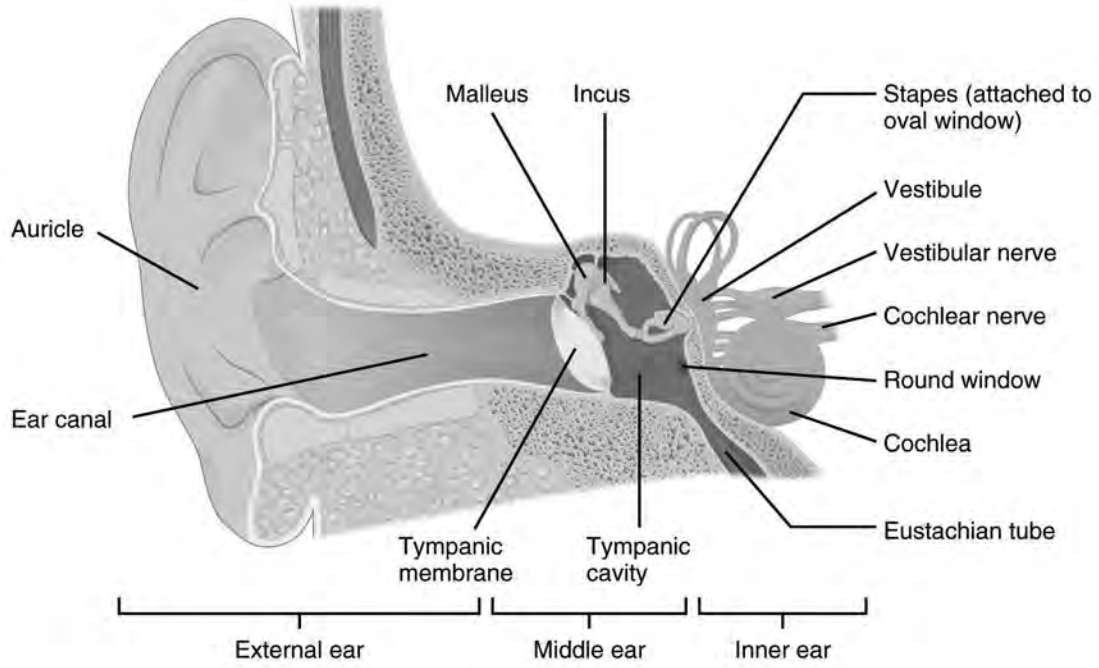
The ears are sense organs and contain two types of sensory receptors. One is sensitive to the stimulus of gravity and the other one is sensitive to sound.

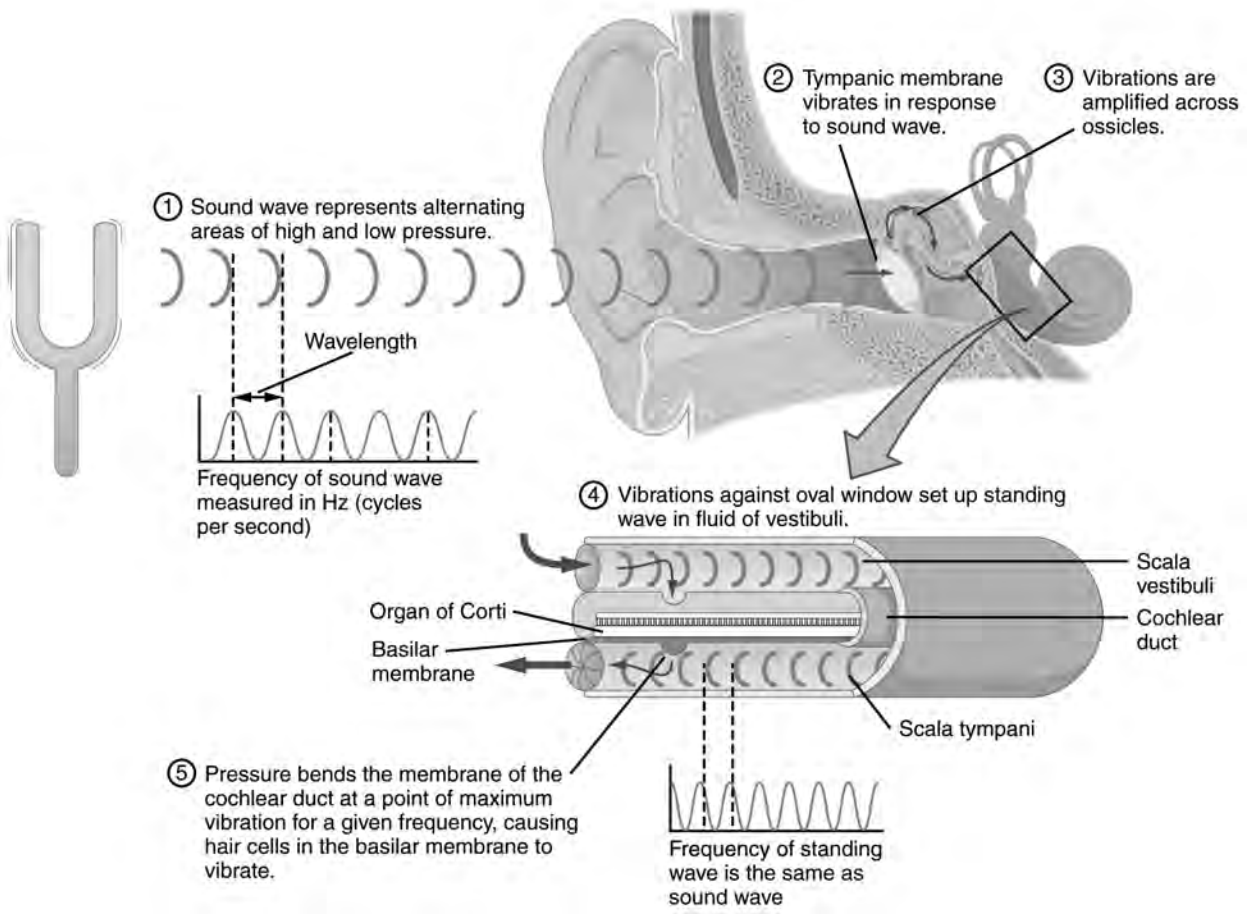
The ear consist of three regions: an External air-filled region; a middle air-filled region and an inner fluid-filled region.

Functioning of the ear

Hearing

Sound waves are directed by the pinna trough the external auditory canal causing the eardrum to vibrate. The vibration let the malleus, incus and stapes to vibrate, amplifying the intensity of the vibration. The vibration are passed by the stapes through the oval window into the inner ear. Pressure waves are set up in the perilymph fluid of the vestibular duct in the inner ear. As the pressure waves pass, this cause the basal membrane to move and push against the hair cells of the organ of Corti that lie in the basilar membrane of the cochlear duct. The organ of Corti in involved in sound detection and pitch analysis. Each hair cell is connected to its own auditory nerve receptor. Nerve impulses are initiated and transmitted along the auditory nerve to the brain where they are interpreted as sound.





OpenStax College, "Sensory Perception," OpenStax_CNX, June 28, 2013, http://cnx.org/content/m46577/1.4/.

Balance

There are two kinds of balance: ***Static balance and dynamic balance.***

Static balance involves sensing the position of the head with regarding to gravity, this is necessary to maintain posture and keeping you from falling over. Static balance is detected by the maculae in the vestibule. The maculae consist of hair cells embedded in a layer of jelly. On top of the jelly are the Otoliths (calcium carbonate crystals) which respond to the force of gravity. As the head moves, the otoliths move causing a pull on the hair cells and this generates nerve impulses to the brain.

Dynamic balance involves sensing the speed and direction that the head moves. Cristea, which is in the ampulla of the semi-circular canals, contain hair cells embedded in the cupula. The semi-circular canals are filled with endolymph and as the endolymph moves past the cupula the direction and speed is deflected. The sensory hairs react to the deflection by sending nerve impulses to the brain.

The Human Endocrine System

The Endocrine system consist of endocrine glands that produce and secrete hormones directly into the blood. The endocrine system control various activities in your body.

A ***gland*** is a group of cells that is specialised to produce a specific chemical substance such as a specific hormone.

Hormones are chemical messengers that control reproduction, growth, metabolic process and the way you respond to your surroundings.

Location and function of human endocrine glands

Gland	**Location and description**	**Hormone/s**	**Function/s**
Testes *(male gonads)*	Oval and lies in the scrotum outside the abdominal cavity in men	Testosterone	**Testosterone:** secondary sexual characteristic during puberty; stimulates sperm production
Ovaries *(female gonads)*	Two ovaries in the abdomen on either side of the uterus in woman	Oestrogen and Progesterone	**Oestrogen:** secondary sexual characteristics during puberty; stimulates the thickening of the lining of uterus to prepare for pregnancy **Progesterone:** stimulates thickening of the lining of the uterus to prepare for pregnancy; during pregnancy it maintains function of the uterus and prevent ovulation

Pancreas	In the abdomen behind the stomach Contains alpha and beta cells grouped together in the islets of Langer-hans	Beta cells secrete Insulin Alpha cells secrete Glucagon	**Insulin:** lowers the concentration of glucose in the blood by making muscles and cells absorb glucose **Glucagon:** promotes the conversion of glycogen into glucose to increase the concentration of glucose in the blood
Adrenal gland	Triangular shape above each kidney	Adrenaline; Cortisol and Aldosterone	**Adrenaline:** prepare body for emer-gencies by Increasing the heart rate, stimulating the conversion of glycogen to glucose, increase depth and rate of breathing, decrease blood supply to skin and digestive system *(to allow more blood flow to muscles and brain)*, dilating the pupils of the eyes to let in more light in order to improve sight **Cortisol:** anti-allergic, anti-stress and anti-inflammatory functions **Aldosterone:** regulates the salt and mineral concentration in the extracel-lular fluids
Thyroid gland	Butterfly shaped with two lobes just below the larynx in front of the trachea.	Thyroxin	**Thyroxin:** regulates growth and development in children; speeds up the heart rate and metabolism; stimulates the digestive system to break down carbohydrates to raise blood glucose levels; help maintain body temperature; promotes normal functioning of nervous system and increase alertness and reflexes

Pituitary gland *(Mater gland)*	Pea-sized gland at the base of the brain; is linked to the Hypothalamus; has two lobes anterior and posterior lobe	Anterior produce several hormones: Thyroid stimulating hormone (TSH); Follicle stimulating hormone (FSH); Luteinising hormone (LH); Prolactin (PRL); Growth hormone (GH). Posterior lobe: Does not produce its own hormones but stores and release ADH produced by the Hypothalamus.	**TSH:** stimulates the thyroid gland to produce the hormone thyroxin; regulates the concentration of thyroxin in the blood **FSH:** stimulates the development of follicles in the ovaries in females and production of sperm in the testes in males **LH:** in females it causes the Graafian follicle to mature into corpus luteum and stimulates secretion of hormones oestrogen and progesterone In Males it stimulates secretion of testosterone by the testes **Prolactin:** stimulates production of breast milk in females **GH:** stimulates protein synthesis and the growth of muscles and bones; It also promotes breakdown of fats as an energy source
Hypothalamus	In the brain just above the brainstem	One of the hormones is ADH *(antidiuretic hormone)*	Forms part of the nervous system and endocrine system and links the two together Secrete Hormones that either stimulates or inhabit the release of hormones from the Pituitary gland **ADH** – Regulate the balance of water and salts in the body

Homeostasis in humans

The body is exposed to many external and its own internal environment changes and is therefore continuously making adjustments to keep its internal environment stable.

The maintenance of a constant internal environment within an organism is called **Homeostasis.**

Homeostasis is essential for life. In order for a body to function at its optimum level, various factors have to be kept at a constant level.

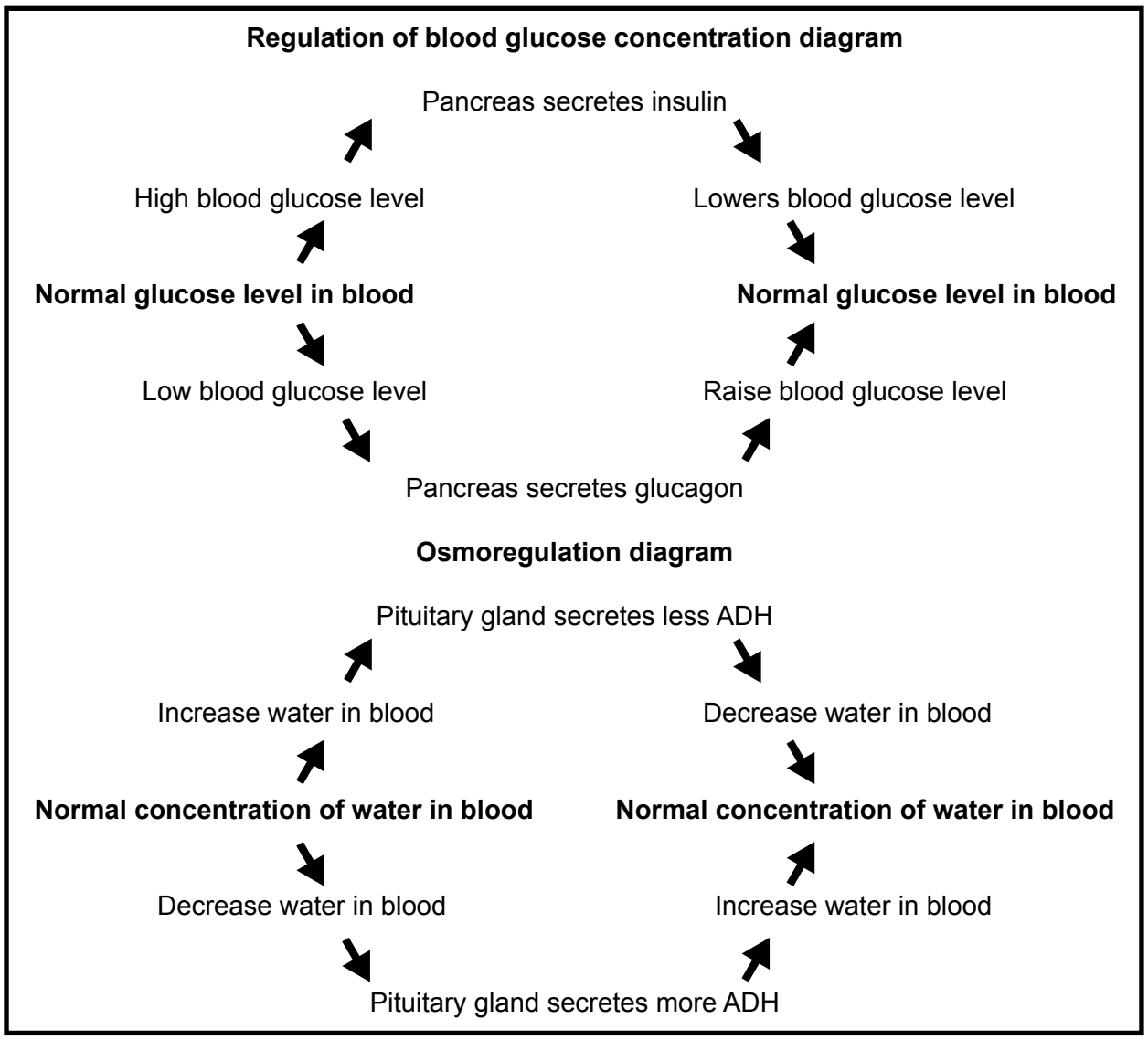
Some of these factors are:

- **Temperature:** Enzymes will denature or become inactive if the temperature is not kept close to 36.5°C. Deviations from the core temperature can be life threatening.
- **Carbon dioxide:** A toxic waste product of cellular respiration. Too much Carbon dioxide in the blood will lower the PH of the tissue fluid and this can affect the functioning of various enzymes.
- **Glucose:** With too little glucose there will be a shortage of energy and will affect the metabolic functions.
- **Water:** Regulates the concentration of salts inside and outside of cells. With an incorrect amount of water the concentration of salts will be upset and metabolic reactions will not occur correctly.

Homeostasis is achieved by negative feedback mechanisms that are controlled by the endocrine and nervous systems.

A negative feedback system has three parts:

1. **A Receptor** that monitors environmental changes and alerts the appropriate control centre.
2. **A Control centre** analyses the information and determines an appropriate response.
3. **An Effector** responds and corrects the imbalance.



Thermoregulation

Humans function at an optimum core temperature of 37°C and deviations from the core temperature can be life threatening. The most important homeostatic organ for thermoregulation in humans is the skin.

The human skin

The human skin is the largest organ in the human body. There are receptors (thermo-receptors) in the skin that respond to heat and cold. The thermo-receptors transmit impulses to the spinal card and brain to make us aware of the temperature outside.

The skin consists of layers: ***The epidermis, the dermis and subcutaneous (fatty) layer.***

The epidermis: a thin layer made of stratified epithelium. It contains keratin which makes it waterproof. The innermost layer produce a pigment, melanin, which protects tissues from harmful ultraviolet rays from the sun.

The dermis: thicker layer that contains soft areolar connective tissue which joins the skin to the muscle tissue. The dermis contains the following:

- Hair follicles: hair grows from follicles. Oil secreted by the sebaceous glad alongside the follicle keep the hair lubricated.
- Sweat glands: coiled glands with a duct leading to a pore on the surface of the skin. They release sweat that contains salts and urea. They help control temperature.
- Blood vessels: runs throughout the dermis and controls how much heat is brought near the skin.
- Sensory organs: receptors that sense heat, cold touch pain and pressure.

Subcutaneous (fatty) layer: smooth out the contours of the body and help to insulate the body from heat loss and provides storage for reserve energy.

Vasodilation and vasoconstriction

Increase body heat:
When the body heat of a person increase, the Ruffini's corpuscles in the skin are stimulated and send messages to the hypothalamus and the person will start feeling hot. The information is transmitted to other parts in the brain to initiate responses.

Conscious reactions are: removing clothing, drinking a cold drink etc.

Subconscious reactions are: decrease in voluntary muscle activity; Increase sweating in increase water evaporation to cool down the skin; blood flow to the skin is increased through vasodilation. ***Vasodilation*** is the widening of blood vessels, specifically arteries and arterioles, to increase blood flow.

Decrease body heat:
When the body heat of a person decrease, Krause's end bulbs in the skin are stimulated and send messages to the hypothalamus and the person will start feeling cold. The information is transmitted to other part of the brain to initiate responses.

Conscious reactions are: Jumping up and down; adding clothing etc.

Subconscious reactions are: Increase voluntary muscle activities causing shivering which generate heat; hair on the skin will be pulled upwards forming goose bumps; blood flow to the skin are reduced through vasoconstriction. ***Vasoconstriction*** is the narrowing if the blood vessels, specifically arteries and arterioles, to restrict blood flow.

5. Diversity, Change and Continuity

Evolution by natural selection

Evidence of evolution

Evolution is the change in the hereditary characteristics of populations over the course of many generations to remain adapted to changes in their environment.

There are different kinds of evidence that support the theory of evolution: **Fossil record; Modification by decent, Biogeography and Genetics.**

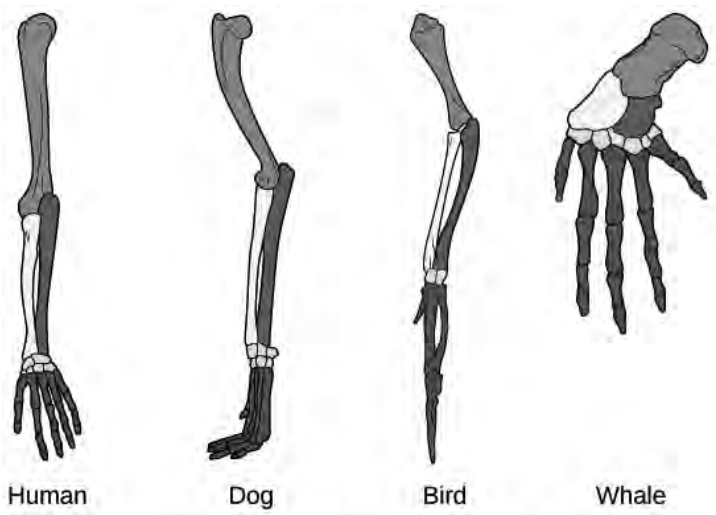
Fossil record:

Fossils are traces or remains of organisms from the past.
In most cases only the hard parts of an organism become fossilised.
Fossil layers can be dated, and palaeontologists (scientist who studies fossils) can determine when different organisms lived on earth.
The fossil record supplies information about the history of life on Earth and it supports the idea that earlier life forms evolved into more recent life forms and that all living organisms have a common ancestor.

Descent with modification:

Decent of modification means that all living organisms today are related by decent from a common ancestors that lived in the past. If two living things shares a feature there is a possibility that they came from a common ancestor. These shared patterns are called homologies. As vertebrates evolved the same bones were modified and some were put to different uses.

For example, the bones in the appendages of a human, dog, bird, and whale all share the same overall construction resulting from their origin in the appendages of a common ancestor. Over time, evolution led to changes in the shapes and sizes of these bones in different species, but they have maintained the same overall layout. Scientists call these synonymous parts homologous structures.



OpenStax College, "Understanding Evolution," OpenStax_CNX, June 26, 2013, http://cnx.org/content/m44568/1.5/.

Biogeography

Biogeography is the study of the geographic and historical distribution of animals and plants of Earth.

The continents has once formed a single landmass called Pangaea, which broke up slowly and drifted apart over millions of years. This is called continental drifting. Continental drifting offers an explanation for the existence of similar fossils and rocks on different continents. Different plants and animals on different land masses evolved separately.

Genetics

Scientist can map the evolutionary relationships between species by comparing the DNA of many organisms.

Difference between a hypothesis and a theory

Hypothesis: a possible answer or explanation for something, an idea that has not be proven, is formulated to explain the observation.

Theory: once the hypothesis has been tested and proven and well supported with evidence.

History of the Theory of evolution

The evolution theory is supported by various kinds of evidence, but can still change as new evidence is found. Many scientist are still working today to further our understanding of evolution.

Lamarckism

Jean-Baptiste Lamarck (1744-1829) was a French scientist. He recognised that the evolutionary changes in organisms explain the fossil record. He believed that evolution was mostly due to organisms adapting to their environments, and he incorrectly believed that individual organisms could pass these acquired features on to their offspring.

For example, Lamarck thought that giraffes evolved their long necks by each generation stretching further to reach leaves in trees, and this change in body shape was then inherited by subsequent generations.

Lamarck's ideas about evolution were rejected by scientists.

From our understanding of Genetics it is clear that acquired characteristics cannot be passed on to the next generation, and individuals do not adapt physically to their environments, they are born adapted or not adapted.

Darwinism

Charles Darwin (1809-1882) was an enthusiastic observer of nature. From 1831 to 1836, Darwin travelled around the world on H.M.S. Beagle, including stops in South America, Australia, and the southern tip of Africa. He observed and collected specimens of animals, plants, rocks and fossils. When he returned from his sea voyage, he spent the rest of his life developing his evolutionary ideas which led to the theory of natural selection.

His ideas focused on adaption to the environment by natural selection.

Natural selection, also known as “survival of the fittest” is the more prolific reproduction of individuals with favourable traits that survive environmental change because of those traits. Organisms without those traits die.

Punctuated Equilibrium

Darwin’s ideas about evolution explained that it took place in small steps and after a long time new species formed that were different from their ancestors. This was known as gradualism. The fossil record also show examples of gradual evolution.

In 1972 two scientist, Niles Eldredge and Stephen Jay Gould, proposed the theory of punctuated equilibrium. They noticed that if you study the fossils of organisms found in subsequent geological layers, there are long intervals when species are the same – they are equilibrium. These are punctuated by short periods of drastic change in which species become extinct and were replaced by new species.

Formation of new species

Speciation is the process by which new species arise from existing species.

The most common environmental condition that leads to speciation is geographic isolation. Geographic isolation is where a population of the same species is separated by natural barriers such as a mountain, desert or water barrier. The two isolated populations of an original species are subject to different environmental influences. The two separated species evolve over time, through the process of natural selection. They become so different from the original species that they can no longer interbreed when they meet up again and this means that they have become new species.

Darwin observed species of organisms on different islands that were clearly similar, yet had distinct differences. For example, the ground finches inhabiting the Galápagos Islands comprised several species with a unique beak shape. The species on the islands had a graded series of beak sizes and shapes with very small differences between the most similar. He observed that these finches closely resembled another finch species on the mainland of South America. Darwin imagined that the island species might be species modified from one of the original mainland species. Upon further study, he realized that the varied beaks of each finch helped the birds acquire a specific type of food. For example, seed-eating finches had stronger, thicker beaks for breaking seeds, and insect-eating finches had spear-like beaks for stabbing their prey. This is an example of new species that evolved through geographic isolation.

An example of speciation through geographic isolation in plant is the Baobab. Madagascar was part of the Africa continent. As continental drift took place, Madagascar become separated from Africa. The population of Baobabs become isolated from the rest of the Baobabs species. The environmental conditions on Madagascar changed from the environmental conditions that prevailed on the mainland of Africa. The population of Baobabs on Madagascar adapted to the environments on the island due to natural selection.

Baobabs in Madagascar

Baobabs in Africa

Bernard Gagnon, March 14, 2007, http://en.wikipedia.org/wiki/File:Adansonia_grandidieri04.jpg

Muhammad Mahdi Karim, January, 2011, http://en.wikipedia.org/wiki/File:Baobab_Adansonia_digitata.jpg

Evolution in present times

Resistance to insecticides in insects

Insects have short life cycles and produce the next generation in a shorter time period and we are able to witness evolution by natural selection in action in a population of insects that become resistant to a particular insecticide (chemicals used to kill insects).

- A pest insect are sprayed with an insecticide for the first time.
- In the insect population, some individuals may have resistance genes.
- The resistance individuals are more likely to survive.
- The the other insects without the resistance gene die.
- The survivors mate and produce off spring (second generation).
- The next generation will have a greater number of individuals with the resistance gene.
- The third generation will have an even higher resistance to the insecticide.
- Insects that do not have the resistance gene do not survive to reproduce.
- The result is that the population evolved and become adapted to the environment and insecticide-resistant.

Resistance of HIV to anti-retroviral

HIV (human immunodeficiency virus) causes AIDS. ARVs (anti-retroviral drugs) have been developed to combat HIV. Some of the viruses may have the genetic make-up to be resistant to ARVs and survive and reproduce so that this trait is passed on to the next generation of viruses. After a couple of generations the population of viruses consists mainly of viruses with the ability to survive the treatment. The population of viruses has evolved and become resistant to ARVs.

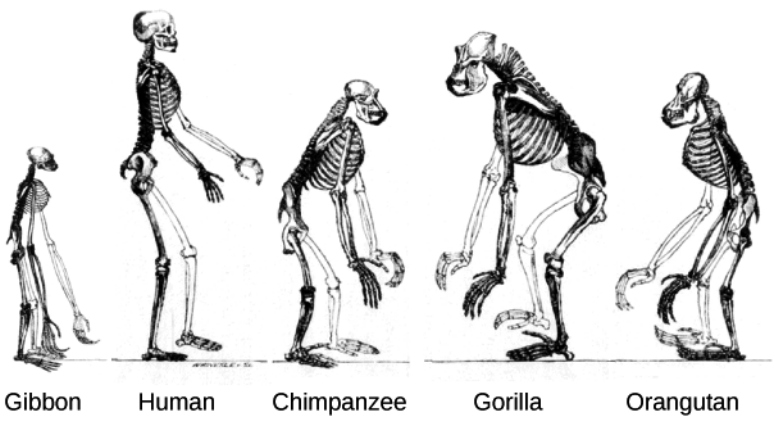
Human evolution

Humans did not develop from apes, they share a common ancestor.

Primates are a group of mammals to which all apes and humans belong.
Evidence for the close relationship between humans and apes comes from the similarities of their anatomy. They have, for example the following similarities:

- Highly developed brains;
- Eyes at front of the head which give them binocular vision;
- Hands and feet with an opposable thumb or big toe which allows them to grasp objects easily.

Humans are classified together with gorillas, bonobos, chimpanzees and orang-utans as Great Apes.



OpenStax College, "The Evolution of Primates," OpenStax_CNX, April 29, 2013, http://cnx.org/content/m44696/1.4/.

All Great Apes have a similar skeletal structure

Hominin evolution

Humans and their direct ancestors are known as the Hominins and the main difference is that hominins walk upright. They have a bipedal gait. They also have shorter arms, longer legs and a very large brain comparing to their body size.

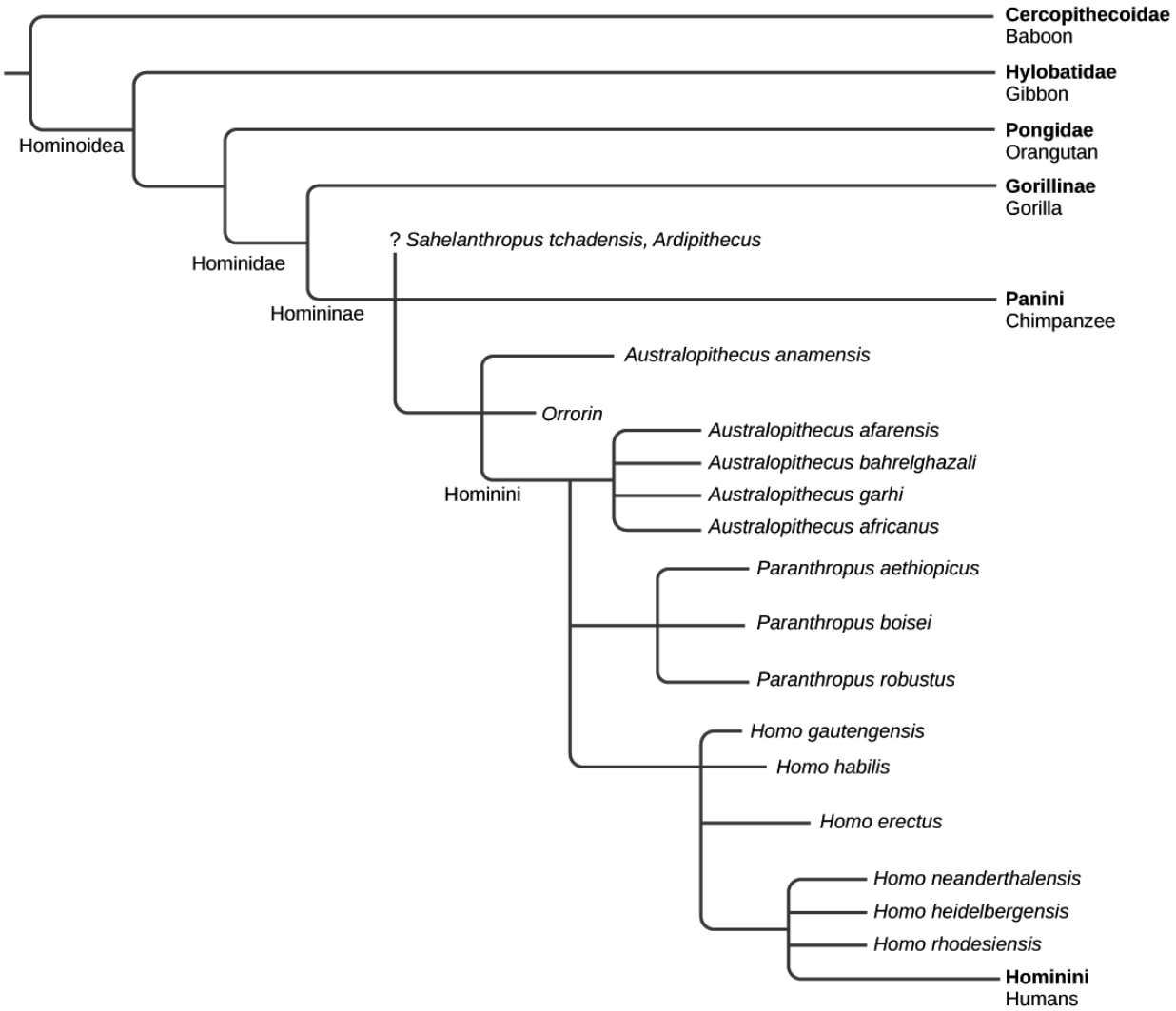
Fossil evidence

Hominin evolution has taken place over approximately 6 million years. Scientist have found thousands of hominin fossils and pieced them together. These fossils support the evidence provided by anatomy of a close evolutionary relationship between humans and the Great Apes.
The shape and size of the fossil bones can tell us about the size of the muscles. The size of the muscle can give us information about what the organism ate and how it moved.

Genetic evidence

Scientists have compared the DNA of humans and Great Apes and found that they are almost identical. The human DNA sequence is most similar to that of the chimpanzee (98.76%) and provide evidence of a close relationship between chimpanzees and humans.

Evolution of modern humans.



OpenStax College, "The Evolution of Primates," OpenStax_CNX, April 29, 2013, http://cnx.org/content/m44696/1.4/.

Out of Africa hypothesis

The out of Africa hypothesis states that Homo sapiens (modern humans) evolved in Africa, and from there migrated to the Middle East, Southern Africa, Europe Central Asia and finally America.

Genetic evidence of the Out of Africa hypothesis

Research of mutations in mtDNA (mitochondrial DNA) in humans around the world have shown that modern humans spread out, about 200 000 years ago, from a small group of humans that arouse in Africa. The mtDNA is traced back to one female, known as mitochondrial Eve. According to research Africans have greater genetic diversity in their mtDNA than humans in the rest of the world. This could mean that humans arose from Africa 200 000 years ago and stayed there for more than 100 000 during which time the mtDNA in different populations mutated causing the diversity in their mtDNA seen today.

Fossil evidence of the Out of Africa hypothesis

Africa has a long and enduring fossil hominin record and includes fossils of the Ardipithecus species, the Australopithecus species and the Homo sapiens.

Ardipithecus phase of human evolution

Fossils found: In 1992, Tim White discovered the fossil of Ardipithecus ramidus in the Middle Awash river valley in Ethiopia. The 4.4 million year old female nicknamed Adri.

Australopithecus phase of human evolution

Fossils found: In 1974, Donald Johanson and Tom Gray discovered a 3.2 million year old female fossil of Australopithecus Afarensis in Ethiopia who was nicknamed Lucy. Below is a photo of Lucy:

OpenStax College, "The Evolution of Primates," OpenStax-CNX, April 29, 2013, http://cnx.org/content/m44696/1.4/.

Discovered: 1947 by Robert Broom and John Robinson in Sterkfontein, South Africa
Age: 2.5 million years old

The skull was nicknamed ‘Mrs Ples’ because it was originally considered to be an adult female from the genus Plesianthropus. Later, it was decided that the skull was actually an Australopithecus africanus individual and there is also some debate about whether this skull was that of a female or male.

See more at: http://australianmuseum.net.au/image/Australopithecus-africanus-skull/#sthash.LtdDIICG.dpuf

REVISION QUESTIONS

Question 1
Various options are provided as possible answers to the following questions. Choose the correct answer.

1.1 Genes only code for…
- A Starch
- B Proteins
- C Glucose
- D Fats

1.2 The Wings of a bat and the forelimb of a seal are examples of …
- A Homologous structures
- B Vestigial structures
- C Analogous structures
- D Common ancestry

1.3 Which one of the following is an explanation based on Darwin's theory of evolution?
- A Humans evolved from Apes
- B A mother who had her appendix removed will give birth to children without an appendix
- C An increase number of TB-causing bacteria are resistant to antibiotics because those that are resistant are able to survive and reproduce
- D Giraffes have long necks because the previous generation stretched their necks to reach tall trees

1.4 Below is a list of fossils discovered in South Africa.
1. Mrs Ples
2. Taung child
3. Little foot
4. Karabo

Which of the fossils above are classified in the genus Australopithecus?
- A 1, 2 and 3 only
- B 1, 2, 3 and 4
- C 2, 3 and 4 only
- D 1, 3 and 4 only

1.5 A mother has blood group B and a Father blood Group O. They have 3 children and an adopted child. The blood groups of the children are:
Sindy = Blood group AB
Marquis = Blood group B
Kenny = Blood group O
George = Blood group B

Which child is adopted?
- A Sindy
- B Marquis
- C Kenny
- D George

1.6 Which one of the following is not a nitrogenous base of RNA?

A Cytosine
B Adenine
C Guanine
D Thymine

1.7 Which one of the following correctly describe the cells produced by meiosis?

	Chromosome complement	Genetic composition
A	Haploid	Different
B	Diploid	Identical
C	Diploid	Different
D	Haploid	Identical

1.8 The part of the Brain that secretes various hormones is:

A Cerebellum
B Pituitary gland
C Corpus callosum
D Medulla oblongata

1.9 Which one of the Following refers to development in some birds where the eggs hatch outside the body and the young are born immobile and totally dependent on its parents?

A Vivipary and precocial development
B Ovipary and altricial development
C Vivipary and altricial development
D Ovipary and precocial development

1.10 The statement below refer to adaptation of flowers for pollination

1. Male and female flowers are found on different plants
2. Stigma below anthers
3. Male and females gametes mature at the same time

Which combination of adaptations refer to self –pollination?

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 AND 3

(10 x 2) **(20)**

Question 2

Give the correct biological term for each of the following descriptions.

2.1 An allele that is not shown/expressed in the phenotype when found in the hetero zygous condition.
2.2 Chromosomes other that sex chromosomes.
2.3 The complete disappearance of a species from Earth.
2.4 The condition where an organism has more than two complete sets of chromo somes in a cell
2.5 The fluid that surrounds a developing baby.
2.6 The release of ovum from the ovary.
2.7 The production of genetically identical organisms using biotechnology.
2.8 Layer of skin in which the sweat glands are located.

2.9 Widening of blood vessels.
2.10 Narrowing of blood vessels.
2.11 The exact position of a gene on a chromosome.
2.12 The time when the body undergo physical changes and becomes sexually mature.
2.13 The process by which new species arise from existing species.
2.14 Sensing the position of the head with regarding to gravity.
2.15 A sudden, random change in the DNA of an organism.

(15)

Question 3

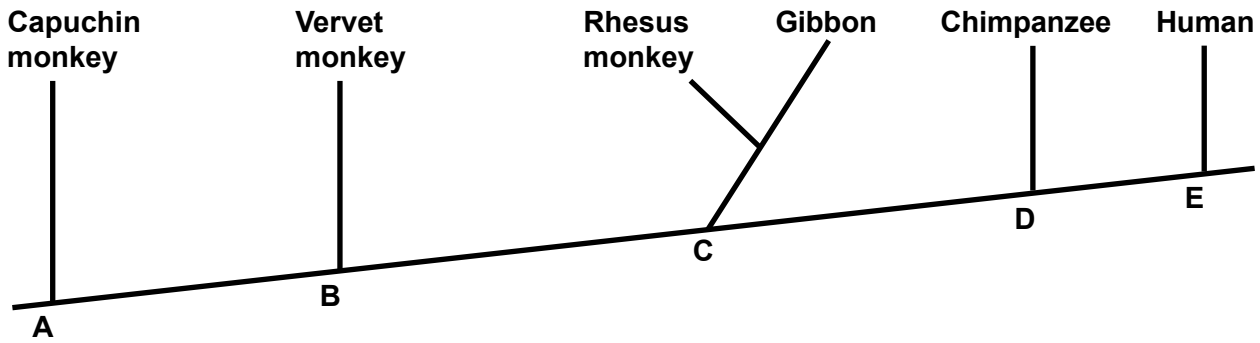
Indicate whether each of the statements in column 1 applies to A only, B only, Both A and B or none of the items in Column 2.

Column 1	Column 2
3.1 The Study of the past and present distribution of individual species as evidence for evolution	A: Palaeontology B: Biogeography
3.2 The evidence used to support the Out of Africa hypothesis	A: Y chromosome B: mtDNA
3.3 Inheritance of the disorder linked to the sex chromosome	A: Colour blindness B: Sickle cell anaemia
3.4 First Homo Species to have Migrated out of Africa	A: Homo habilis B: Homo sapiens
3.5 Natural selection as an explanation of evolution	A: Alfred Wallace B: Charles Darwin
3.6 Organisms have an inherent/internal drive to change	A: Lamarck B: Wallace
3.7 A characteristic that is only expressed when in the homozygous state	A: Recessive B: Dominant
3.8 Influence the inheritance of blood group	A: Multiple alleles B: Co-dominance
3.9 A type of mutation in which adenine is lost/ deleted from a DNA base triplet	A: Frame shift mutation B: Point mutation
3.10 A characteristic that humans share with other primates	A: Binocular vision B: Opposable thumb

(2x10) **(20)**

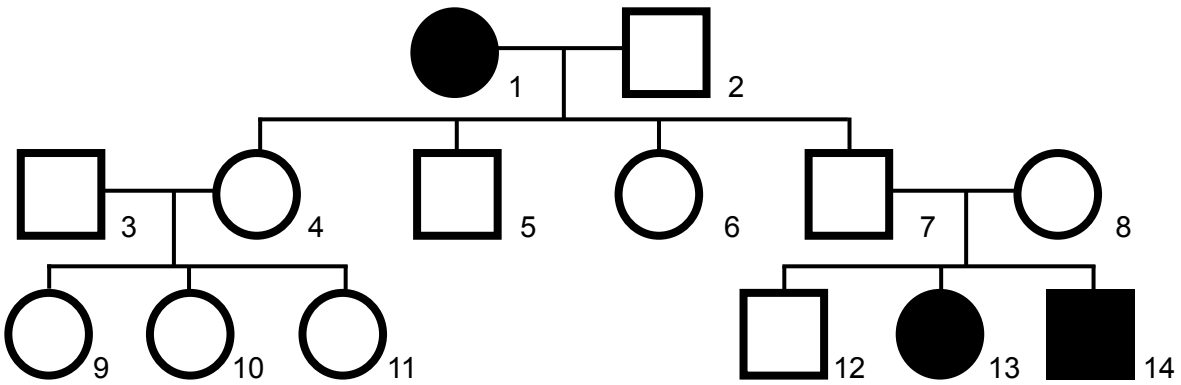
Question 4

The diagram below represents a phylogenetic tree showing primate evolution. The letter A to E indicate the characteristics which are shared by the different species of primates which follow the letter. The point where various species of primates differ from each other is indicated by the branching-off into new species



4.1 Which letter represents a common characteristic of all primates? (1)
4.2 List three structural characteristics represented by the letter named in 4.1 (3)
4.3 Which organism is most similar to the Chimpanzee? (1)
4.4 Name three structural characteristics of the skull that makes the organism named in question 4.3 different from the Chimpanzee. (3)
4.5 Write down the name of the organism that display the characteristics of B but not Characteristics of C D and E. (1)

Question 5
The pedigree chart shows the occurrence of Albinism on a family



Key


Normal male

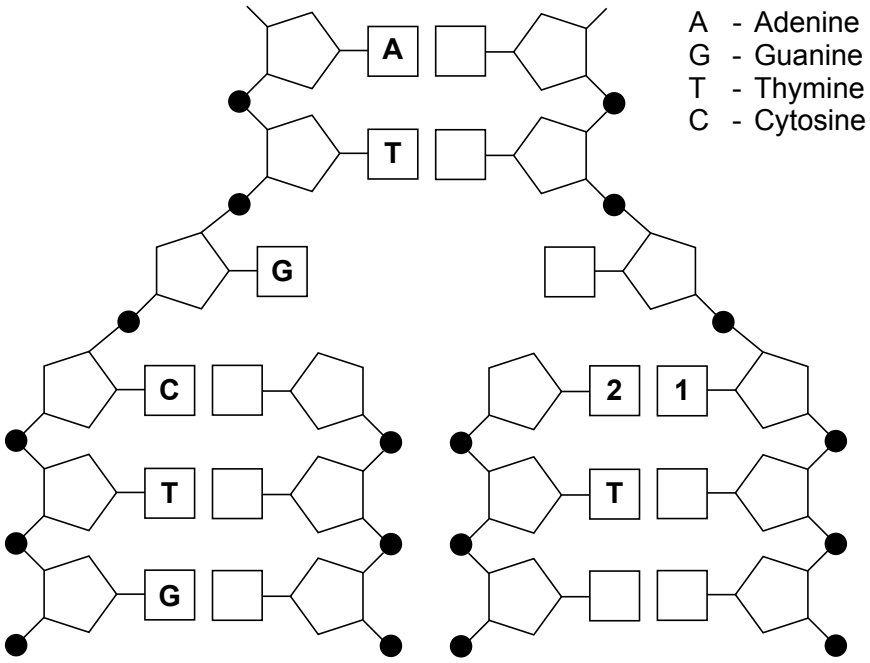

Normal female


Male with albinism


Female with albinism

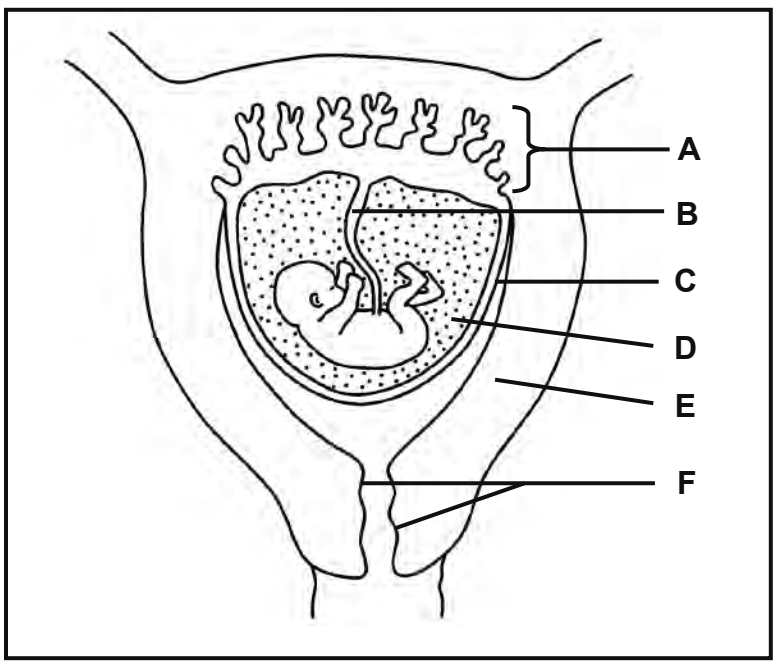
5.1 Does albinism appear to be dominant or recessive according to the pedigree chart? Explain your answer. (3)
5.2 Is the inheritance of albinism sex-linked? (2)
5.3 Why does none of the children of individual 1 have albinism? (2)
5.4 What is the genotype of individual 8? Explain your answer (3)
Use the letter A for Normal pigment and a for Albinism.

Question 6
Study the diagram below.



6.1 Name the process represented in the diagram. (1)
6.2 When exactly will this process take place in a cell? (1)
6.3 Name 1 and 2 in the diagram. (2)
6.4 State 3 ways in which the structure of RNA differs from the structure DNA shown in the diagram. (3)

Question 7
Study the diagram below.



Match and name the structures A - F with the descriptions below:

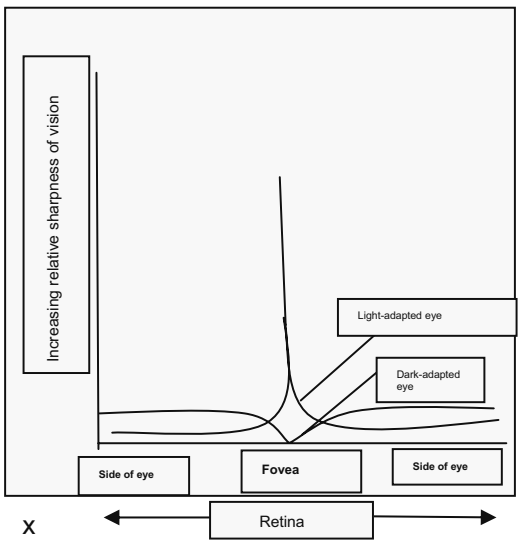
7.1 Where gaseous exchange occurs between mother and foetus.
7.2 Removes excretory products from the foetus.
7.3 Contains strong muscles which will pull the foetus out during birth.
7.4 Clamped and cut after the baby is born.
7.5 Acts as shock absorber for the developing foetus.
7.6 A sac filled with fluid to protect the foetus.

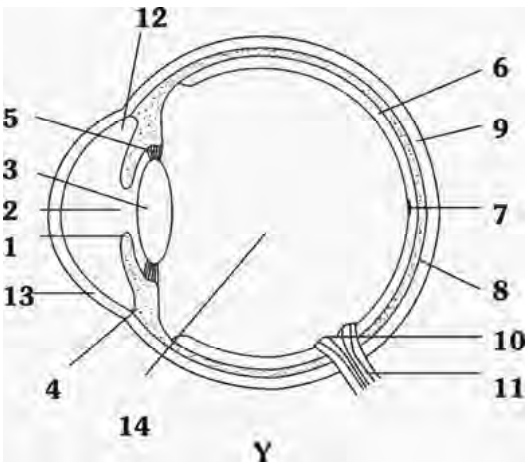
(6)

Question 8

Graph X below compares the visual acuity of a light-adapted and a dark adapted eye
Diagram Y illustrates a section through an eye.

Answer the questions on the illustrations.





8.1 Refer to diagram Y. Provide the label of the structures that represents the following statements:
a. Is tough, elastic and transparent.
b. An area in the retina that does not contain any light receptors.
c. Changes the size of the pupil under different light conditions.
d. Refracts light from an object.
e. Alters shape of lens.
f. The layer that has light receptor cells.
g. Absorbs light and prevents it from scattering within the eyeball.
h. The layer that requires Vitamin A to function efficiently.
i. The area where the sharpest image is formed.
j. Gives the eye its colour.
k. Provides nutrition to the eye.

(12)

8.2 Explain the changes that take place in part 1 if the person walks from bright light into dim light. (8)
8.3 In what way does the process explained in 8.2 serve to protect the eye? (3)

Refer to diagram X

8.4 In which type of eye is the relative acuity of vision the greatest at the fovea? Give a reason for your answer. (3)

8.5 In which type of eye is the relative acuity of vision the greatest at the side of the eye? Give a reason for your answer. (3)

8.6 A person with normal vision who has been looking at a stage play, looks at a popcorn in his hand, finds that his vision is blurred for a split second before becoming clear. Explain why this occurs and how adjustment is brought in the eye. (13)

8.7 What is this process of adjustment called? (1)

Question 9

The Following table shows the effect of certain hormones in the human body. Complete the table by naming the gland and hormones.

Gland	Hormone	Effect of hormone
1	2	Increase heart beat, respiration rate and blood pressure
3	4	Stimulates thyroxin production
5	6	Induces ovulation
7	8	Maintains the normal calcium and phosphate level of the blood
9	10	Normal development of immunological responses
11	12	Increase the rate of metabolism
13	14	Regulation of salt and water balance
15	16	Stimulates conversion of glycogen to glucose

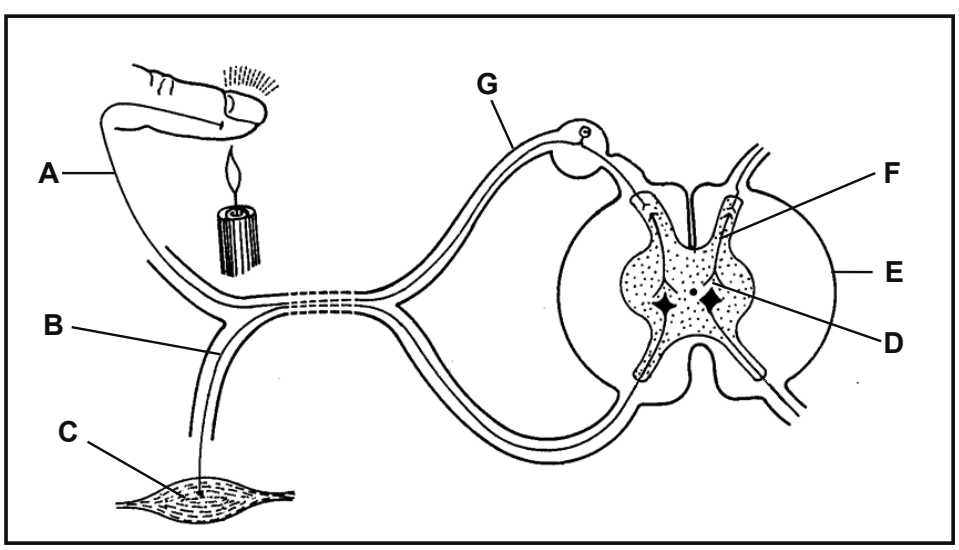
(16)

9.2 Describe the role of the hypothalamus and the adrenal glands in bringing about changes to the blood vessels of the human skin and explain why these changes take place.

Content (17)
Synthesis (3)

Question 10

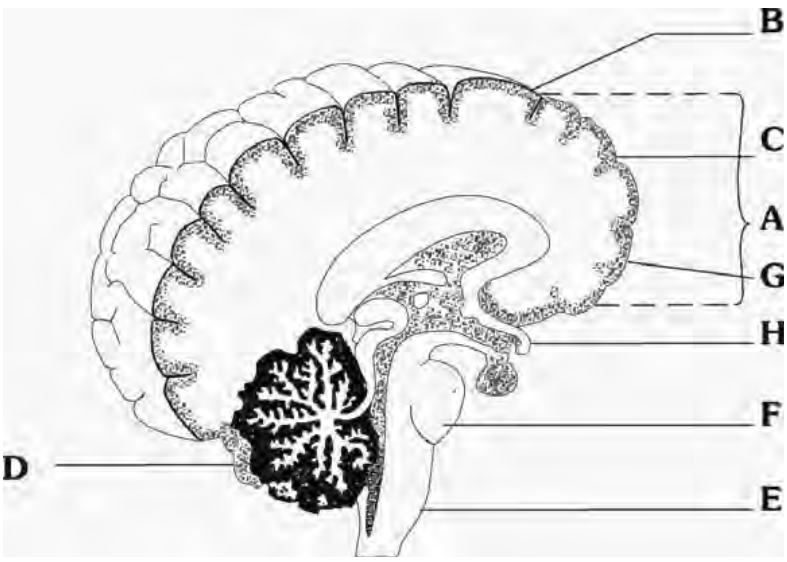
The diagram below shows a part of the central nervous system.



10.1 Give labels for each of the following
- a. C
- b. Microscopic gap D
- c. E
- d. F
- e. G (5)

10.2 Define the term 'reflex action'. (3)
10.3 Give two examples of reflex actions. (2)
10.4 Explain the consequence for the body if A is damaged. (2)
10.5 List the components of a reflex arc and explain their function. (10)
10.6 Draw a labelled diagram of Neuron B to show its structure. (5)

Question 11
Study the diagram below then answer the questions.



11.1 Identify and give the functions of structures A, D and E (12)
11.2 Name the part of the brain that is responsible for:
1 – relaying incoming messages to the correct parts of the brain.
2 – controlling the release of certain hormones from the hypothesis.
3 – controlling dilation and constriction of blood vessels.
4 – conducting impulse from the medulla oblongata to the more anterior parts of the brain.
5 – regulating body temperature. (5)

Answers:

Question 1
1.1 B 1.2 A 1.3 C 1.4 B 1.5 A 1.6 D 1.7 A 1.8 B 1.9 B 1.10 C

Question 2
2.1 Recessive Allele 2.2 Autosomes 2.3 Extinct 2.4 Polyploid 2.5 Amniotic fluid
2.6 Ovulation 2.7 Cloning 2.8 Dermis 2.9 Vasodilation 2.10 Vasoconstriction
2.11 Locus 2.12 Puberty 2.13 Speciation 2.14 Static balance 2.15 Mutation

Question 3
3.1 B 3.2 B 3.3 A 3.4 None 3.5 A and B 3.6 A 3.7 A 3.8 A and B 3.9 A

Question 4
4.2 A
4.3 - Opposable thumbs with power and precision grip
- Bare Fingertips with nails
- Long Arms
- Eyes in front
- Large brain compare to body size
- Two mammary glands
- Sexual dimorphism
(Any 3 of the above)
4.4 The Human
4.5 Gently curved jaws
Flat Face
Well-developed chin
No pronounced brow ridges
Spaces between teeth bigger
Larger brain size
(Any 3 of the above)
4.5 Vervet Monkey

Question 5
5.1 Recessive, none of the first generation children have albinism although they have the gene for it. Albinism results when a person inherits an albinism gene from both of his or her parents.
5.2 No there are a both female and male person with albinism. The Grandmother (1) and a grandson (14) and granddaughter (13)
5.3 The albinism gene is recessive and if the male (2) does not have the gene for albinism the children will have his dominant normal pigmented gene. A person needs to inherit an albinism gene from both parents.
5.4 Aa, Individual 7 inherit the Albino gene from his parent and the only way that his children will be albinos is if individual 8 also had the gene for albinism.

Question 6
6.1 DNA replication
6.2 Between cell division/ before mitosis /before meiosis
6.3 1- Guanine ; 2 – Cytosine
6.4 - RNA is a single strand and DNA is a double strand
- RNA has uracil and DNA has thymine

- RNA has single bases and DNA has paired bases
- RNA has ribose and DNA had deoxyribose
- RNA is much shorter whereas DNA is longer
- RNA maybe linear, straight or looped and DNA is helix

(Any three)

Question 7

7.1 A - Placenta
7.2 A/B – Placenta/ umbilical cord
7.3 E - Uterus
7.4 B – Umbilical cord
7.5 D – Amniotic fluid
7.6 C - Amnion

Question 8

8.1 a. 3 ; b. 10 ; c. 1 ; d 3,12,13 and 14 ; e. 4 and 5 ;
f.6 ; g. 8 ; h.6 ; i. 7 ; j.1 ; k.8,13 and 14

8.2 In bright light the radial muscles of the iris relax and the circular muscles are contracted. The diameter of the pupil is small and less light enters the eye. As the person walks into dim lights the radial muscles of the iris contract and the circular muscles relax. Diameter of the pupil gets bigger and more light enters the eye.

8.3 Prevent too much light entering the eye and over-stimulating the retina. Over- stimulating the retina may damage the photoreceptors (rod and cones).

8.4 Light adapted eye. Fovea centralis has the greatest number of cones. Cones are mainly used for seeing in bright light. Cones are both light sensitive and has the highest visual acuity.

8.5 Dark adapted eye. Have more rods. These are mainly used for seeing in dim light. Visual acuity is greater at the sides of the retina.

8.6 When a person is looking at a distance, as on the stage, the eye is focussing for distant vision. The ciliary muscles are relaxed. Sclera lies more backwards, suspensory ligaments are tauter, and lens is less convex. Focal length increases so that the image can fall on the retina. When the person now has to focus on the hand, the lens of the eye has to be adjust to form a clear image (Temporary blurring). The ciliary muscles contract, sclera is pulled forward, the suspensory ligaments become slack and the lens become more convex. The refractive power of the lens increase and the image falls on the retina.

8.7 Accomodation.

Question 9

1. Adrenal medulla
2. Adrenalin
3. Pituitary
4. TSH
5. Adenohypophysis
6. Lutenizing hormone LH
7. Parathyroid
8. Parathormone
9. Thymus
10. Thymosin
11. Thyroid
12. Thyroxin
13. Adrenal cortex
14. Aldosterone
15. Alpha cells of the Islet of Langerhans
16. Glucagon

9.2 Hypothalamus

- The changes in temperature is detected by the thermo-receptors in the skin.
- Stimulus converted to nerve impulse.
- Transmitted to the hypothalamus.

- Hypothalamus sends impulses to the muscle layer in the arterioles of the skin (Max 3)

On a cold day the arterioles close to the surface constrict/vaso- constriction occurs
- Less blood flows to capillaries close to the surface
- Sweat production decreases/less sweat is lost.
- Less heat is radiated from the body / less heat is lost. (4)

On a hot day the arterioles close to the surface dilate/ vaso- dilation occurs.
- More blood flows to the capillaries close to the surface.
- Sweat production increases / more sweat is lost.
- More heat is radiated from the body/ more heat is lost. (4)

Adrenal gland
- Secretes adrenalin.
- Hormone that prepares the body to cope with emergency/danger/stress.
- Adrenalin cause the blood vessels of the skin to constrict.
- Less blood flows to the surface of the skin.
- Because the skin is not an important organ during an emergence.
- Re-directing more blood / more oxygen and food to vital organs.
- To enable the body to respond during an emergency. (Max 6)

Question 10

10.1. a. C - Effector/muscle; b. D - Synapse; c. E - Spinal cord
d. F - Connector neuron/interneuron; e. G - Dorsal root/spinal nerve

10.2 A rapid automatic response to an external stimulus received by an organ or receptor.

10.3 Pulling your hand away from a hot object / blinking / coughing / sneezing / any appropriate stimulus and response. (Any two)

10.4 Impulse will not reach the Central Nervous System (CNS) / The body will be unaware of the stimulus an no reflex action will occur causing harm to the body.

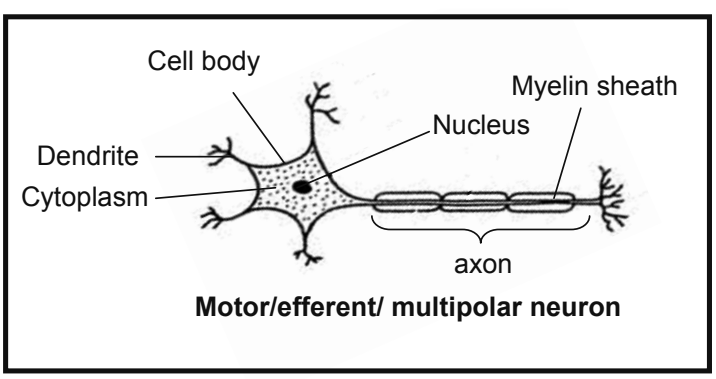
10.5 Receptor – receive external stimuli and converts it to an impulse.

Sensory neuron – transmit impulse from receptor along dorsal root of spinal nerve to the spine cord.

Connector neuron in the grey matter of the spinal cord – makes a synaptic contact between sensory and the motor neuron.

Motor neuron – conducts the impulse via ventral root of spinal nerve to the effector organ.
Effector organ – responds to bring about the necessary action.

10.6



Motor/efferent/ multipolar neuron

Question 11

11.1

A – Cerebrum:

- Origin and control of all voluntary movements
- Controls higher mental activities.
- Perception of sensation.
- Seat of emotions.

D – Cerebellum:

- Co-ordinates the action of all voluntary muscles to bring about controlled movement.
- Control muscle tonus and balance.

E – Medulla oblongata:

- Controls all involuntary actions e.g. respiration, heart beat, salivation, peristalsis, blood vessel dilation and constriction, sleep ect.
- Conducts impulses to and from spinal cord and the brain.
- Allows for crossing over of nerves between spinal cord and brain.

11.2

1 - Thalamus;
2 - Hypothalamus;
3 - Medulla oblongata
4 - Pons varolii;
5 - Hypothalamus.

JOIN THE NEDBANK BURSARY PROGRAMME.

THE DIFFERENCE STARTS WITH OUR YOUTH.

#YOUNGDIFFERENCEMAKER

The Nedbank External Bursary Programme is open to full-time Undergraduate and Honours students who are studying towards qualifications in the financial sector with a strong focus on STEM (Science, Technology, Engineering and Mathematics) and Green Economy skills.

If you do not have the financial means to study full-time towards your degree or diploma at a South African public university or university of technology, and you meet the below criteria, it is time to become a **#YoungDifferenceMaker!**

CRITERIA FOR SELECTION:

To be eligible for the Nedbank bursary, you must:

- be a South African citizen; and
- have a proven financial need, as determined by your household income.

Must have:

- a minimum academic average of 65% in the year that you are applying for the bursary;
- a minimum academic average of 65% for the required subjects aligned with the qualification you plan to study towards at university;
- not completed your grade 12 or senior certificate with mathematics literacy; and
- successfully obtained admission approval to a South African public university or university of technology for the undergraduate qualification you plan to study towards.

The application process:
We screen bursary applications against our external bursary selection criteria and award bursaries through the Nedbank Educational Trust, at the sole discretion of the trust.

The screening process:

- We will only consider bursary applications submitted online via the link we have provided.
- Incomplete bursary applications will be rejected.
- Bursary applications will be screened and shortlisted according to the qualifying criteria.

If you are shortlisted, we will ask you to:

- submit the relevant documents for financial review;
- participate in psychometric and other assessments; and
- attend an interview.

YOUR FUTURE STARTS NOW!

All candidates will receive feedback on the status of their application at the completion of the recruitment and selection process.

Contact information:
Email: Unlockyourambition@nedbank.co.za

Closing date for applications is 31 August 2024.

Bursaries are granted at Nedbank's sole discretion.
For the complete application process and a list of required documents, please visit our website at **www.nedbank.co.za/bursary**

NEDBANK