

Reproduction Advantage of asexual reproduction	Reproduction Advantage of sexual reproduction
Reproduction Roles of meiosis and fusion of gametes in a sexual life cycle	Reproduction Prime difference between male and female sexes
Reproduction Functions of the epididymis and seminal vesicle	Reproduction Functions of the oviduct and endometrium
Reproduction Source and role of FSH	Reproduction Positive feedback in the menstrual cycle

Offspring have new gene combinations, giving the variation needed for adaptation to a changed environment.

Produces genetically identical offspring of a parent already adapted to an existing environment.

The male gamete travels to the female gamete, so it is smaller with less food reserves than the egg, and many more are produced.

Meiosis breaks up parental combinations of alleles and halves the chromosome number; fusion of gametes (fertilization) produces new combinations and restores diploid.

Oviduct: carries the egg to the uterus; site of fertilization. Endometrium: blood-rich uterus lining where the embryo implants.

Epididymis: stores sperm while they mature. Seminal vesicle: secretes fluid with fructose and mucus into semen.

High oestradiol before ovulation stimulates the pituitary to release more LH (and FSH): the LH surge triggers ovulation.

Anterior pituitary. Stimulates follicle development and oestradiol secretion by follicle cells.

Reproduction

Role of progesterone in the cycle

Reproduction

Final stage of fertilization in humans

Reproduction

Two hormonal steps at the start of IVF

Reproduction

Where are the gametes of a flowering plant?

Reproduction

Why is reproduction in a hermaphrodite plant still sexual?

Reproduction

Two features of an insect-pollinated flower and their functions

Reproduction

Three methods that promote cross-pollination

Reproduction

How does self-incompatibility work?

Nuclear membranes of sperm and egg nuclei dissolve; all condensed chromosomes join one mitosis, producing two diploid nuclei.

Secreted by the corpus luteum; maintains the endometrium and inhibits FSH and LH (negative feedback).

Male gametes inside pollen grains; female gametes (egg cells) inside ovules in the ovary.

Normal secretion of hormones is suspended (down-regulation), then artificial doses of FSH induce superovulation.

Large coloured, scented petals attract insects; nectaries give a sugary reward; sticky stigma catches pollen from insects.

Haploid male and female gametes still fuse at fertilization, giving a zygote with a new combination of alleles.

Pollen carrying an S allele matching the receiving plant is rejected: it fails to germinate or its tube stops growing, so gametes come from different plants.

Pollen and stigma mature at different times; separate male and female flowers or plants; pollen carried between plants by animals or wind.

Reproduction

Why is inbreeding a disadvantage?

Reproduction

Seed dispersal versus pollination

Reproduction

Mobilization of food reserves in germination

Reproduction **HL only**

What triggers puberty?

Reproduction **HL only**

Four stages common to spermatogenesis and oogenesis

Reproduction **HL only**

Why does oogenesis give one egg but spermatogenesis four sperm?

Reproduction **HL only**

Acrosome reaction

Reproduction **HL only**

Cortical reaction

Dispersal moves seeds away from the parent after fertilization; pollination moves pollen from anther to stigma before fertilization.

It decreases genetic diversity and vigour, as harmful recessive alleles become homozygous more often.

Increased GnRH release by the hypothalamus in late childhood, raising LH and FSH release, which increases sex hormone production.

Water uptake; gibberellin stimulates amylase production; starch digested to sugars, proteins to amino acids; transported to the growing embryo.

In oogenesis both meiotic divisions divide the cytoplasm unequally, giving one large egg and polar bodies; spermatogenesis divides equally.

Mitosis, cell growth, two divisions of meiosis, differentiation.

After fusion, cortical granules release enzymes by exocytosis that alter the zona pellucida so no more sperm can pass through.

Acrosome releases enzymes that digest a path through the zona pellucida, letting the sperm reach the egg membrane.

Reproduction **HL only**

Blastocyst and implantation

Reproduction **HL only**

What does a pregnancy test detect, and with what?

Reproduction **HL only**

Key structural feature of the placenta

Reproduction **HL only**

Why is having a placenta an advantage?

Reproduction **HL only**

What triggers childbirth?

Reproduction **HL only**

Why was the HRT-CHD correlation not causal?

Inheritance

Why does a diploid cell have two copies of each autosomal gene?

Inheritance

P, F1 and F2 generations

hCG from the embryo or developing placenta, using monoclonal antibodies that bind to hCG.

Hollow ball of cells (trophoblast, inner cell mass, cavity) formed by about day 5; implants in the endometrium at about day 7.

The foetus can be retained in the uterus to a later stage of development than in mammals without a placenta.

Placental villi give a large surface area for exchange between maternal and foetal blood.

HRT users had higher socioeconomic status, which itself lowers CHD risk. Randomized controlled trials showed HRT slightly increases CHD risk.

A fall in progesterone allows oxytocin secretion to rise; oxytocin causes contractions, which stimulate more oxytocin (positive feedback).

P: pure-breeding parents crossed. F1: their offspring. F2: offspring of F1 crossed together or self-pollinated.

It formed when two haploid gametes, one from each parent and each carrying one copy, fused into a zygote.

Inheritance

Why can pea plants self-fertilize?

Inheritance

Gene versus allele

Inheritance

Phenotype

Inheritance

Why is an allele recessive?

Inheritance

Phenotypic plasticity

Inheritance

Cause of phenylketonuria (PKU)

Inheritance

**Single-nucleotide polymorphism
(SNP)**

Inheritance

**How many alleles of a gene can an
individual inherit?**

A gene is a heritable factor at a locus influencing a characteristic; an allele is one alternative form of a gene.

They produce both male gametes (in pollen) and female gametes (in ovules) on the same plant, so self-pollination is possible.

It usually codes for a non-functional protein, so its effect only shows when no dominant (functional) allele is present.

The observable traits of an organism, resulting from genotype and environmental factors.

A recessive allele of an autosomal gene for the enzyme that converts phenylalanine to tyrosine.

Capacity to develop traits suited to the environment by varying patterns of gene expression; not a change in genotype; may be reversible.

Only two, although any number of alleles can exist in the gene pool.

A base position where the nucleotide differs between individuals; SNPs create multiple alleles in a gene pool.

Inheritance

ABO alleles and dominance

Inheritance

Codominance example

Inheritance

Incomplete dominance example

Inheritance

What determines sex in humans?

Inheritance

**Why are X-linked traits more common
in males?**

Inheritance

Genotype of a haemophilia carrier

Inheritance

Pedigree clue for a recessive allele

Inheritance

**Genetic basis for prohibiting marriage
between close relatives**

Blood group AB ($I^A I^B$): heterozygote has a dual phenotype with both A and B antigens.

I^A and I^B are codominant; both are dominant to i .

The sex chromosome in the sperm: X gives XX (female-typical), Y gives XY (male-typical).

Mirabilis jalapa (four o'clock flower): red $\times$ white gives pink, an intermediate heterozygote.

$X^H X^h$: a heterozygous female, unaffected but able to pass X^h to children.

The X carries far more genes than the Y, and males have one X, so a single recessive X-linked allele is expressed.

Relatives are more likely to carry the same rare recessive allele, so children are more likely to be homozygous recessive.

Two unaffected parents have an affected child.

Inheritance

**Inductive versus deductive reasoning
in pedigrees**

Inheritance

Continuous variation

Inheritance

Discrete variable example

Inheritance

**Six aspects shown by a box-and-
whisker plot**

Inheritance **HL only**

Independent assortment

Inheritance **HL only**

Dihybrid ratios for unlinked genes

Inheritance **HL only**

Locus

Inheritance **HL only**

**Why do linked genes fail to assort
independently?**

A trait can take any value in a range, due to polygenic inheritance and/or environment, e.g. skin colour.

Inductive: deducing a general pattern from some cases. Deductive: using that pattern to work out specific individuals' genotypes.

Outliers, minimum, first quartile, median, third quartile, maximum.

ABO blood group: distinct categories with no intermediates.

$AaBb \times AaBb$ gives 9:3:3:1. $AaBb \times aabb$ (test cross) gives 1:1:1:1.

Alleles of unlinked genes go into gametes in all combinations equally, because bivalents orient randomly at metaphase I.

Their loci are on the same chromosome, so alleles travel together into gametes unless crossing over separates them.

The position of a gene on a particular chromosome, e.g. HBB (beta-globin) on chromosome 11.

Inheritance **HL only**

Recombinant

Inheritance **HL only**

Chi-squared formula and decision rule

Inheritance **HL only**

Degrees of freedom for a dihybrid chi-squared test

Homeostasis

Homeostasis

Homeostasis

Four homeostatic variables in humans

Homeostasis

Negative feedback

Homeostasis

Insulin: source, stimulus, effect

Homeostasis

Glucagon: source, stimulus, effect

$\chi^2 = \Sigma(O - E)^2/E$. If $\chi^2 >$ critical value at $p = 0.05$, reject the null hypothesis.

An individual or gamete with a combination of alleles not on either parental chromosome, produced by crossing over (or independent assortment).

Maintenance of the internal environment of an organism: variables kept within preset limits despite fluctuations in the external environment.

Number of classes – 1 = 3; critical value at $p = 0.05$ is 7.815.

A change from the set point triggers a response that reverses it, from above or below, returning the variable to the set point.

Body temperature, blood pH, blood glucose concentration, blood osmotic concentration.

α cells of pancreatic islets; low blood glucose; liver cells break glycogen to glucose and release it into the blood.

β cells of pancreatic islets; high blood glucose; liver and muscle cells absorb glucose and convert it to glycogen.

Homeostasis

How do pancreatic hormones reach target cells?

Homeostasis

Physiological basis of type 1 diabetes

Homeostasis

Physiological basis of type 2 diabetes

Homeostasis

How can type 2 diabetes be prevented?

Homeostasis

Roles of the hypothalamus and pituitary in thermoregulation

Homeostasis

Effect of thyroxine on body temperature

Homeostasis

Uncoupled respiration in brown adipose tissue

Homeostasis

Vasodilation versus vasoconstriction

Autoimmune destruction of β cells, so little or no insulin is secreted. Treated with insulin injections.

Secreted directly into blood capillaries and transported in the blood to cells with the matching receptors.

Healthy diet low in sugars and fat, regular exercise and keeping a healthy body mass.

Target cells become resistant to insulin.
Risk factors: obesity, inactivity, diet, age, genetics.

Raises the basal metabolic rate, so cells generate more heat.

Hypothalamus compares temperature with the set point and controls effectors; via the pituitary (TSH) it increases thyroxine secretion when cold.

Vasodilation: skin arterioles widen, more blood near surface, more heat lost.
Vasoconstriction: arterioles narrow, less heat lost.

Protons leak back across the inner mitochondrial membrane, so energy is released as heat instead of making ATP.

Homeostasis

Responses to overheating

Homeostasis **HL only**

Excretion versus osmoregulation

Homeostasis **HL only**

Ultrafiltration

Homeostasis **HL only**

Role of the proximal convoluted tubule

Homeostasis **HL only**

Role of the loop of Henle

Homeostasis **HL only**

Effect of high ADH on collecting duct cells

Homeostasis **HL only**

Where are osmoreceptors, and what do they control?

Homeostasis **HL only**

Blood supply during vigorous physical activity

Excretion: removal of metabolic wastes such as urea. Osmoregulation: regulation of osmotic concentration (osmol L^{-1}).

Vasodilation of skin arterioles and sweating (evaporation removes heat); behaviour such as seeking shade.

Reabsorbs all glucose and amino acids, most ions and water; toxins and unwanted solutes stay in the filtrate.

High pressure in the glomerulus forces small solutes and water from plasma into Bowman's capsule; cells and large proteins stay in the blood.

Aquaporins move from intracellular vesicles into the cell membrane, so more water is reabsorbed and urine is concentrated.

Ascending limb actively transports Na^+ out, keeping the medulla at high osmotic concentration so collecting ducts can reabsorb water.

Large increase to skeletal muscles; reduced to gut and kidneys by vasoconstriction; brain roughly constant.

In the hypothalamus; they detect blood osmotic concentration and control the rate of ADH secretion by the pituitary.

Which organ's blood supply stays constant during sleep, rest and exercise?

The brain, which needs a steady supply of oxygen and glucose.