

Class 9 Science: Reproduction — How Life Continues

Comprehensive NCERT Interactive Notes, Flowcharts, Conceptual Solutions & 10-Year Solved Board PYQ Bank (2016–2025)

Subject: Grade 9 Biology (Ch 11)

Target: CBSE Board Exams & School Finals

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1. Fundamentals of Reproduction & Modes of Continuity

Every living organism has a definite lifespan—it is born, grows, matures, reproduces, and eventually dies. **Reproduction** is the fundamental biological process by which living beings produce new individuals of their own kind, ensuring the continuation of species across generations.

CORE DEFINITION WHAT IS REPRODUCTION?

Reproduction is the biological mechanism through which organisms transmit genetic information to offspring. Without reproduction, a species would become extinct as older members die out.

1.1 Comparison of Reproduction Modes

Living organisms reproduce primarily via two distinct modes: **Asexual Reproduction** (involving a single parent) and **Sexual Reproduction** (involving two parents and gamete fusion).

Feature	Asexual Reproduction	Sexual Reproduction
Number of Parents	Single parent involved.	Two parents (Male and Female) involved.
Gamete Formation	No gamete formation or fusion.	Formation and fusion of haploid gametes (Sperm & Egg).
Cell Division Type	Mitosis only.	Meiosis (for gametogenesis) and Mitosis (for zygote growth).
Genetic Offspring	Offspring are genetically identical to parent (Clones).	Offspring inherit mixed traits from both parents (Variations).
Speed & Energy	Fast process, requires less time and energy.	Slower process, requires time and finding compatible mate.
Adaptability & Evolution	Low adaptability to environmental changes; no variation.	High adaptability; variations accumulate for natural selection.
Examples	Bacteria, Amoeba, Yeast, Hydra, Bryophyllum, Potato.	Flowering plants (Angiosperms), Fish, Birds, Mammals, Humans.

MEMORY TRICK ASEXUAL VS SEXUAL

A-Sexual = Alone (Single parent, Exact Clone, Mitosis only).

Sexual = Synthesis (Two parents, Sperm + Egg, Meiosis, Unique Variations).

2. Asexual Reproduction & Agricultural Applications

Asexual reproduction occurs in unicellular microbes, simple multicellular organisms, and many plant species. The offspring are exact copies of the single parent (clones) created via **mitosis**.

2.1 Natural & Artificial Vegetative Propagation

Vegetative propagation is the asexual formation of new plants from vegetative parts like stems, roots, or leaves, without seeds.

A. Natural Vegetative Propagation Mechanisms

- **Underground Stems:** Fleshy underground stems such as *Potato* (tubers with buds/eyes) and *Ginger* (rhizomes) sprout new independent shoots without seeds.
- **Stem Cuttings:** Plant cuttings of *Sugarcane* or *Money Plant* grow roots and shoots from nodes when planted in moist soil.
- **Foliar (Leaf) Buds:** Leaves of *Bryophyllum* produce tiny plantlets along their notched margins. When leaves fall on moist soil, plantlets detach and grow into mature plants.

B. Artificial Propagation Methods in Agriculture



1. **Cutting:** A healthy shoot with nodes/internodes is cut at 45–60° angle, lower leaves removed, inserted in nutrient soil, and watered until roots sprout (e.g., Rose, Sugarcane).
2. **Grafting:** Stem of desired variety (**Scion - Plant B**) is fitted into a slit on a rooted plant (**Stock - Plant A**). The junction is wrapped with cloth/film to prevent moisture loss and pest entry until healed. Used for high-yield fruit varieties.
3. **Layering:** A flexible branch of a shrub (e.g., Lemon, Jasmine) is bent down and middle part buried under moist soil. After 10–15 days, roots develop from the buried segment; it is then cut from the parent plant to grow independently.
4. **Tissue Culture (Micropropagation):** Tiny tissue samples taken from the shoot tip (apical meristem) are grown on sterile nutrient media to form mass plantlets. Ensures virus-free, disease-free, high-yield crops (e.g., Banana, Orchids).

BRIDGING SCIENCE & SOCIETY KRISHI VIGYAN KENDRAS (KVKS)

Under ICAR (Indian Council of Agricultural Research), KVKS train farmers nationwide in modern grafting and tissue culture techniques, boosting fruit yield, farm income, and rural self-reliance.

2.2 Asexual Reproduction in Microorganisms & Simple Animals

- **Budding in Yeast & Hydra:**
 - In unicellular *Yeast*, small bulb-like outgrowths (buds) form on the parent cell, mature, and separate.
 - In multicellular *Hydra*, repeated cell division at a specific body site forms a bud that develops into a tiny individual and detaches.
- **Spore Formation in Fungi (Rhizopus & Aspergillus):**
 - Fungi develop thread-like filaments called **hyphae** with swollen sacs called **sporangia** at the tips.
 - Sporangia produce millions of lightweight, microscopic, single-celled **spores** that float in air currents.
 - When spores land on moist, warm organic substrates (like moist bread at 25–35°C), they germinate into new fungal colonies.

HISTORICAL SPOTLIGHT LOUIS PASTEUR & GERM THEORY

Louis Pasteur disproved the old theory of "Spontaneous Generation" by proving that life arises only from pre-existing life. His discovery established the Germ Theory, cell theory extensions, sterilisation of instruments, and modern food refrigeration.

3. Sexual Reproduction & The Role of Meiosis

If two diploid parents ($2n = 46$ chromosomes in humans) contributed complete cell chromosomes during reproduction, the offspring would contain double chromosomes ($4n = 92$), causing genetic instability. Nature solves this problem through **Meiosis**.

3.1 Meiosis & Genetic Variation

- **Reduction Division:** Meiosis reduces chromosome number by half in reproductive cells ($2n \rightarrow n$).
- **Gametes:** The resulting haploid cells ($n = 23$ chromosomes in humans) are gametes (Sperm in males, Egg in females).
- **Restoration of Chromosome Number:** During fertilisation, haploid sperm (23) + haploid egg (23) = diploid zygote (46).
- **Genetic Recombination & Diversity:** Random alignment and segregation of 23 pairs of chromosomes yields 2^{23} (>8.3 million) possible genetic combinations in gametes, explaining why siblings differ from each other and their parents.

EXAM INSIGHT SIGNIFICANCE OF VARIATION

Variations generated by meiosis enable species to adapt to changing environments (e.g., altitude tolerance, disease resistance) and serve as the raw material for natural selection and evolution.

4. Sexual Reproduction in Flowering Plants (Angiosperms)

Flowers are the reproductive structures of angiosperms. A complete flower consists of four distinct whorls arranged on the receptacle.

4.1 Floral Structure & Functions

Whorl Name	Individual Unit	Nature & Function
Calyx (Outermost)	Sepal (Green)	Protects the inner floral organs during the bud stage.
Corolla (2nd Whorl)	Petal (Coloured/ Fragrant)	Attracts insect and bird pollinators; protects stamens/pistil.
Androecium (3rd Whorl)	Stamen (Male Unit)	Consists of Anther (produces pollen grains containing male gametes) and Filament (support stalk).
Gynoecium (Innermost)	Pistil / Carpel (Female Unit)	Consists of Stigma (sticky landing platform), Style (elongated neck tube), and Ovary (swollen base with ovules containing egg cells).

4.2 Pollination Mechanisms & Adaptation Strategies

Pollination is the transfer of pollen grains from the anther to the stigma.

- **Self-Pollination:** Pollen transfer occurs within the same flower or another flower on the same plant.
- **Cross-Pollination:** Pollen transfer occurs from the anther of one plant to the stigma of a flower on another plant of the same species. Creates higher genetic variation.

Pollination Agents & Floral Adaptations

Pollination Type	Pollen Characteristics	Floral & Stigma Features	Examples
Wind (Anemophily)	Lightweight, dry, smooth, produced in massive quantities (5,00,000+ per flower).	Small, non-showy, feathery/long stigma exposed to air currents; no nectar.	Wheat, Maize, Rice, Grasses.
Insect (Entomophily)	Sticky, spiny, produced in moderate quantities (20,000–40,000 per flower).	Large, brightly colored petals, rich nectar, sweet fragrance, sticky stigma.	Sunflower, Rose, Hibiscus, Mustard.
Water (Hydrophily)	Water-resistant, lightweight, mucilage-coated.	Submerged or floating flowers; stigma adapted to catch floating pollen.	Vallisneria, Hydrilla.
Bird (Ornithophily)	Large sticky pollen grains.	Sturdy, tubular, bright red/yellow flowers with abundant watery nectar.	Coral Tree, Hibiscus (Sunbirds).

4.3 Fertilisation & Post-Fertilisation Transformations



POST-FERTILISATION CHANGES

- **Fertilised Egg (Zygote)** → Embryo (future plant).
- **Ovule** → **Seed** (contains embryo + tough protective coat).
- **Ovary** → **Fruit** (enlarges, ripens to enclose seeds).
- **Petals, Sepals, Stamens, Style, Stigma** → Wither, dry up, and fall off.

FATHER OF INDIAN EMBRYOLOGY PROF. PANCHANAN MAHESHWARI

Pioneered test-tube fertilisation (in-vitro fertilisation) in flowering plants, successfully growing plant embryos on artificial media. Published the classic textbook *An Introduction to the Embryology of Angiosperms* (1950).

5. Sexual Reproduction & Reproductive Strategies in Animals

Animals display diverse reproductive strategies tailored to their environmental habitats to ensure offspring survival.

5.1 External vs. Internal Fertilisation

Parameter	External Fertilisation	Internal Fertilisation
Site of Fusion	Outside female body (in external water medium).	Inside female reproductive tract.
Number of Eggs Laid	Huge numbers (100s to 50,000+ at a time).	Few eggs (1 to 20 at a time).
Egg Protection	Unprotected; vulnerable to water currents and predators.	Highly protected inside eggshell or mother's womb.
Offspring Survival Rate	Very low (high mortality).	Moderate to High.
Animal Groups	Bony fish, Frogs (Amphibians).	Reptiles, Birds, Mammals (Humans).

5.2 Yolk Content & Larval Metamorphosis

- **Low Yolk Strategy (Fish, Amphibians, Insects):** Eggs contain minimal yolk. They hatch quickly into feeding larval stages (e.g., tadpole, caterpillar) that eat organic waste/leaves before undergoing **metamorphosis** into adults.
- **High Yolk Strategy (Reptiles, Birds):** Eggs contain abundant yolk and protective shells, allowing complete embryo development inside the egg prior to hatching.
- **Placental Development (Mammals):** Zygote develops inside the mother's uterus, receiving continuous nourishment via placenta and milk after birth.

6. Human Reproduction & Developmental Biology

6.1 Male Reproductive System

Designed to produce sperm and deliver them into the female reproductive tract.

- **Testes (Testis singular):** Pair of oval glands located inside the **Scrotum** outside the abdominal cavity.
 - Scrotum keeps testes **2–3°C cooler** than body temperature (37°C), essential for spermatogenesis.

- Testes secrete the male sex hormone **Testosterone** (regulates sperm production and secondary sexual traits like facial hair, deep voice, broadening shoulders).
- **Vas Deferens:** Sperm duct carrying sperms from testes to urethra.
- **Accessory Glands (Seminal Vesicles & Prostate Gland):** Secrete fluid rich in nutrients and enzymes that nourishes sperm and forms liquid fluid medium (**Semen**) for sperm motility.
- **Urethra & Penis:** Urethra forms a common passage for semen and urine, extending through the penis.

6.2 Female Reproductive System

Produces eggs, secretes female hormones, and provides the site for fertilisation, implantation, and foetal growth.

- **Ovaries:** Pair of female gonads located in lower abdomen. Produce mature **Egg cells (Ova)** and hormones (**Estrogen & Progesterone**).
- **Oviducts (Fallopian Tubes):** Tubes connecting ovaries to uterus. *Site of fertilisation where sperm meets egg.*
- **Uterus (Womb):** Pear-shaped muscular organ where fertilised egg implants and foetus develops.
- **Cervix & Vagina:** Cervix is the narrow neck opening of uterus into vagina; vagina receives sperm during intercourse and acts as birth canal.

6.3 Sperm vs. Egg (Gamete Asymmetry)

Feature	Sperm (Male Gamete)	Egg / Ovum (Female Gamete)
Size & Shape	Microscopic, streamlined head with long flagellum tail.	Large, spherical cell.
Number Produced	Millions produced continuously per day.	1 mature egg released per month (ovulation).
Motility	Actively motile (swims using tail).	Non-motile (guided by ciliary action in fallopian tube).
Nutrient Storage	No stored yolk/nutrients (carries only nuclear DNA).	Rich cytoplasm containing stored nutrients.

6.4 The Menstrual Cycle (28-Day Period)

In human females, from puberty to menopause (~50 years), ovaries and uterus undergo a monthly cycle.



- **If Fertilisation Occurs:** Zygote undergoes mitotic cleavage, implants into thick uterine wall, placenta forms, and menstrual cycles pause for 9 months.
- **If Unfertilised:** Egg degenerates in 24 hours. Progesterone drops, inner blood-rich uterine lining breaks down, leaving body via vagina as menstrual flow (lasting 3–7 days).

MENSTRUAL HYGIENE & ASHA WORKERS

Use sanitary pads/cups, change every 4–6 hours, wash genitals with clean water (avoid harsh soap), wrap used pads in paper for waste bins. Over 10 Lakh ASHA workers under India's National Health Mission promote maternal care, hygiene, and family health across rural India.

6.5 Pregnancy, Trimesters & IVF Pioneer

- **Gestation Period:** Human pregnancy lasts 9 months (~40 weeks), divided into 3 Trimesters:
 - *1st Trimester (Weeks 1–12):* Organogenesis; embryo becomes **foetus** by week 9.
 - *2nd Trimester (Weeks 13–27):* Rapid growth; mother feels foetal movements.

◦ 3rd Trimester (Weeks 28–40): Final organ maturation, weight gain, position for birth.

PIONEER OF INDIAN IVF DR. SUBHASH MUKHOPADHYAY

Pioneered India's 1st In-Vitro Fertilisation (IVF) test-tube baby, **Kanupriya Agarwal (Durga)**, in Kolkata on October 3, 1978, opening new frontiers in reproductive medicine.

7. Reproductive Health, Family Planning & STIs

7.1 Sexually Transmitted Infections (STIs)

Close physical/sexual contact can transmit infectious pathogens:

- **Bacterial STIs:** Gonorrhoea, Syphilis (curable with antibiotics).
- **Viral STIs:** Genital Warts, Herpes, HIV/AIDS (non-curable, manageable with ART).

7.2 Contraceptive Methods & Family Planning

Category	Mechanism & Devices	STI Protection	Key Notes & Side Effects
Barrier Methods	Condoms (Male/Female), Diaphragms. Physical barrier preventing sperm from entering uterus.	YES (High Protection)	Condoms are the only contraceptive that prevents STIs alongside pregnancy.
Chemical / Hormonal	Oral contraceptive pills. Alters hormone levels to inhibit ovulation.	NO	Pills like <i>Saheli</i> (developed by CDRI Lucknow) are non-steroidal, taken weekly with zero side effects.
Intra-Uterine Devices (IUDs)	Copper-T inserted into uterus by doctor; releases copper ions toxic to sperm.	NO	May cause mild uterine irritation or bleeding in some cases.
Surgical Methods	Vasectomy (cutting/tying vas deferens in males). Tubectomy (cutting/tying fallopian tubes in females).	NO	Permanent surgical sterilisation; blocks gamete transport.

LEGAL WARNING PCPNDT ACT & FEMALE FOETICIDE

Prenatal sex determination using ultrasound is strictly prohibited under the PCPNDT Act in India. Female foeticide distorts the natural sex ratio and is a severely punishable offense.

8. Solved NCERT Exercises & Pause & Ponder Solutions

NCERT Q1 (Revise, Reflect, Refine)

CONCEPTUAL

A flower's anthers are removed before it matures. Later, pollen from another plant of the same species is dusted onto its stigma and seeds are produced. Which process has been ensured here?

Correct Answer: (ii) Cross-pollination

Explanation: Removing anthers (emasculation) prevents self-pollination. Dusting pollen from a separate plant onto the stigma ensures cross-pollination.

Arrange the following stages of sexual reproduction in plants in correct order: (i) Pollen germination on stigma, (ii) Fertilisation, (iii) Pollination, (iv) Formation of zygote.

Correct Sequence: (iii) → (i) → (ii) → (iv)

1. **Pollination (iii)**: Transfer of pollen to stigma.
2. **Pollen Germination (i)**: Pollen tube grows down the style.
3. **Fertilisation (ii)**: Male gamete fuses with egg cell.
4. **Formation of Zygote (iv)**: Diploid fertilised egg cell formed.

Assertion (A): The zygote formed after fertilisation immediately attaches to the uterus wall.

Reason (R): The uterus wall is always prepared to receive the zygote.

Correct Answer: (iv) A is false, but R is true.

Explanation: The zygote undergoes several mitotic divisions (cleavage) into a blastocyst stage over 4–6 days while traveling through the fallopian tube before implanting into the uterus wall (so A is false). The inner uterine lining thickens monthly in preparation for receiving an embryo (so R is true).

Explain why the menstrual cycle stops during pregnancy.

During pregnancy, the implanted embryo produces hormones (like hCG) that signal the corpus luteum and placenta to continuously secrete high levels of **progesterone**. High progesterone maintains the thick, nutrient-rich uterine lining to nourish the developing foetus and inhibits ovulation. As a result, the lining does not shed, stopping menstruation.

9. Eduvista 10-Year CBSE Board PYQ Bank (2016–2025)

Which part of the male reproductive system produces testosterone and maintains scrotum temperature lower than body temperature?

Answer: Testes in Scrotum

The testes produce testosterone and sperms. The scrotum hangs outside the abdominal cavity, maintaining a temperature 2–3°C below body temperature (37°C) essential for sperm maturation.

State the changes that take place in a flower after fertilisation. Mention the fate of ovary and ovule.

Answer: Post-Fertilisation Changes in Flowers:

1. **Ovary**: Grows rapidly, ripens, and transforms into a **Fruit**.
2. **Ovule**: Develops a tough coat and matures into a **Seed** containing the embryo.
3. **Petals, Sepals, Stamens, Style, and Stigma**: Dry up, wither, and fall off.

Compare wind-pollinated flowers with insect-pollinated flowers on the basis of pollen grains and stigma adaptations.

Answer Comparison Table:

- **Wind-Pollinated**: Pollen grains are light, dry, non-sticky, produced in millions. Stigma is long, feathery, exposed to catch airborne pollen.
- **Insect-Pollinated**: Pollen grains are larger, sticky/spiny to attach to insect bodies. Stigma is sticky, compact, situated inside showy fragrant flowers.

- (a) Trace the path of sperm from testes to fertilisation site in human female.
(b) What is placenta? State its two main functions during pregnancy.

Answer:

(a) **Sperm Pathway:** Testes → Epididymis → Vas Deferens → Urethra (Penis) → Vagina (during intercourse) → Cervix → Uterus → **Fallopian Tube (Oviduct)** where it fertilises the egg.

(b) **Placenta:** A disc-embedded tissue in the uterine wall containing villi on the embryo side and blood spaces on the mother's side.

Functions:

1. Provides oxygen and nutrients (glucose, amino acids) from mother to foetus.
2. Removes metabolic waste products (carbon dioxide, urea) from foetus into mother's bloodstream.

An experiment was conducted in two apple orchards (Place A with natural pollinators vs Place B with integrated beekeeping). Orchard B showed 85% fruit setting compared to 40% in Orchard A. Answer:

- (i) Why did Orchard B show higher fruit yield?
(ii) What role do bees play in cross-pollination?

Answer:

- (i) Integrated beekeeping in Orchard B provided a dense population of active honeybee pollinators, significantly boosting cross-pollination rate, pollen deposition on stigmas, fertilisation efficiency, and reducing premature fruit drop.
(ii) Honeybees carry sticky pollen grains from anthers to stigmas while collecting nectar, facilitating efficient cross-pollination indispensable for fruit crops like apples.