

Life Sciences IEB

Part 2

CLASS TEXT & STUDY GUIDE

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GRADE

12

IEB

3-in-1



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Grade 12 **Life Sciences** 3-in-1 Part 2 IEB

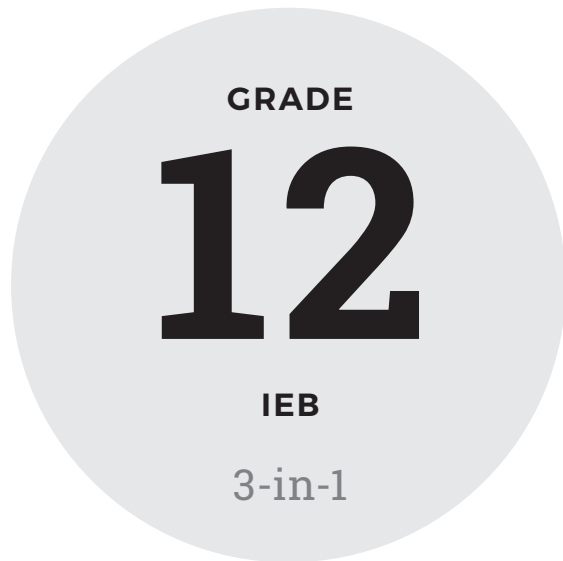
CLASS TEXT & STUDY GUIDE

This book is the second of a comprehensive two-part study guide series which covers the full Gr 12 Life Sciences IEB curriculum. As a pair, the two books cover all the material required for Paper 1 and Paper 2 in your IEB exam. PART 2 guides you methodically through the Environmental Studies and Life Processes in Plants and Animals knowledge strands. PART 1 contains the remaining strands, Life at the Molecular, Cellular and Tissue level and Diversity, Change and Continuity.

Key Features:

- Comprehensive, accessible notes per module
- Carefully selected, graded questions and answers per module
- 'Rapid-fire' questions for key concepts and terms
- Clear, explanatory diagrams
- Up-to-date, relevant material

As you work methodically through this study guide, you will become increasingly prepared to achieve excellent results in your exams.



Life Sciences

Part 2

Liesl Sterrenberg, Helena Fouché & Grace Elliott

Also available

GRADE 12 LIFE SCIENCES PART 1

- Life at the Molecular, Cellular and Tissue Level
- Diversity, Change and Continuity



THIS CLASS TEXT & STUDY GUIDE INCLUDES

- 1 Notes
 - Environmental Studies
 - Life Processes in Plants and Animals
- 2 Questions & Rapid Fire Questions
- 3 Detailed Memos

E-book
available 

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INTRODUCTION TO LIFE SCIENCES

Life Sciences is the scientific study of living things from molecular level to their interaction with one another and the environment.

- ▶ Living systems exhibit levels of organisation from molecules to biomes.
- ▶ Life on earth is dynamic, with homeostasis maintaining balance at every level of organisation.
- ▶ Life is characterised by changes over time.

How science works

- ▶ Fundamental knowledge built on scientific evidence
- ▶ Observation
- ▶ Designing an investigation
- ▶ Making measurements and the importance of scaling
- ▶ Presenting data in the form of drawings, written descriptions, tables and graphs
- ▶ Identifying patterns and relationships in data
- ▶ Societal aspects of scientific evidence
- ▶ Limitations of scientific evidence



UNIT 3: DIVERSITY OF REPRODUCTIVE STRATEGIES IN SOME ANIMALS

Reproduction is a biological process during which a living organism produces offspring. During reproduction an organism's genes are transferred to the next generation, which is essential for the survival and evolution of a particular species.

Reproduction is a characteristic of all **living** organisms.



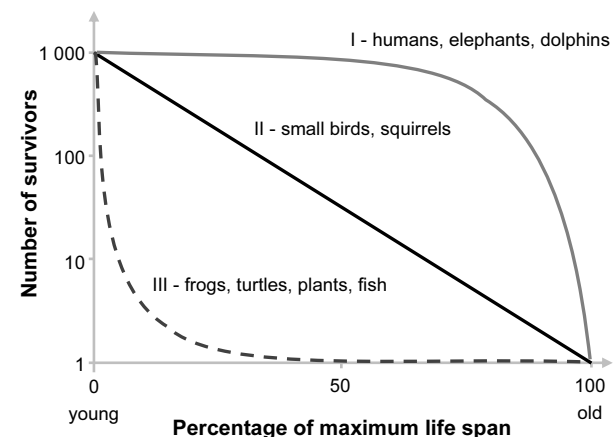
- ▶ Successful reproduction is essential to ensure the continued existence of a species.
- ▶ Animals use various **reproductive strategies** to increase their **reproductive success** in different environments.



Reproductive success is measured by the number of viable offspring an individual produces.

- ▶ Reproductive strategies are structural, functional and behavioural adaptations that increase the chances of fertilisation and survival of offspring.
- ▶ The success of a reproductive strategy depends on how a species utilises energy to produce and care for viable offspring.
- ▶ There are two main types of reproductive strategies:
 - ▶ **r-strategy**
 - ▶ **K-strategy**
- ▶ Some animals such as turtles expend more energy in producing many offspring, but they spend little time or energy in parental care.
- ▶ Many of the offspring will die before adulthood, but sufficient numbers survive to continue the species.
- ▶ This strategy is known as **r-strategy**.
- ▶ Other animals such as lions and elephants, however, produce fewer offspring, but expend enormous amounts of energy for parental care.
- ▶ The offspring have a better chance of surviving to adulthood.
- ▶ This type of strategy is known as **K-strategy**.

- ▶ **Survivorship curves** illustrate the number of organisms that survive at different stages of their life span. K- and r-strategy animals show distinctly different survivorship curves.



There are **three** survivorship curves:

- ▶ Type I: **convex** curve
 - ▶ high survivorship / low mortality in young individuals
 - ▶ low survivorship / high mortality in old individuals
 - ▶ e.g. K-strategy - humans
 - ▶ Type II: straight line
 - ▶ steady survivorship / steady mortality at all ages
 - ▶ individuals have the same chance of dying at any age
 - ▶ e.g. small birds
 - ▶ Type III: concave curve
 - ▶ low survivorship / high mortality in young individuals
 - ▶ high survivorship / lower mortality in old individuals
 - ▶ e.g. r-strategy - frogs
- ▶ There is a wide range of reproductive strategies employed by different species.
 - ▶ The following reproductive strategies are discussed:
 - ▶ **Courtship**
 - ▶ **External vs Internal fertilisation**
 - ▶ **Ovipary, Ovovivipary and Vivipary**
 - ▶ **Amniotic egg**
 - ▶ **Precocial and Altricial development**
 - ▶ **Parental care**

COURTSHIP

Courtship is the behavioural patterns of male and female animals that lead to mating and ultimately offspring.

The purpose of courtship:

- ▶ It ensures that both sexes are ready for mating.
- ▶ It helps to identify mating partners of the same species and so prevent unsuccessful mating between different species, thus saving energy.
- ▶ It helps to choose a suitable mating partner. Females often choose larger, stronger males with more attractive physical features that increases the chances of many healthy offspring.

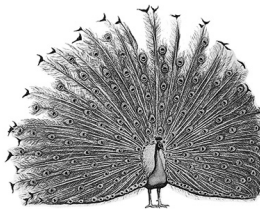
Courtship can take place by using:

- ▶ **Visual stimuli**
- ▶ **Sound stimuli**
- ▶ **Chemical stimuli**
- ▶ **Physical movements**



Visual stimuli

- ▶ The best known example is the **male peacock** who uses his striking, brightly coloured tail feathers to court the female. The female usually chooses the male with the most impressive set of tail feathers.



Male peacock

- ▶ In some birds e.g. **egrets**, the males develop a special plumage during the mating season to attract females.

- ▶ In nocturnal animals, such as **fireflies**, the males use a specific pattern of light flashes to find the right mate. Interested female fireflies send out the same pattern of light flashes, indicating their sexual maturity.

The pattern of light flashes differ from species to species.



Sound stimuli

- ▶ **Male frogs** use sounds to attract the females. Each frog species has its own call. The females make no sounds, but are attracted by the male's calls. The females then choose a mate from the croaking choir of males.
- ▶ **Male birds** also sing to attract females.



Birdsong is not only for courting, but also a signal to demarcate their specific territory.

Chemical stimuli

In some insects and mammal species the females secrete chemical substances, known as **pheromones**. This is a signal to the males that they are sexually mature.

- ▶ **Male moths** can detect pheromones over long distances by means of their large, feathery antennae.



Male moth

- ▶ **Female lions, dogs and domestic cats** also secrete pheromones into the air, attracting the males.

Physical movements

- ▶ **Scorpions** perform a mating dance to ensure that both sexes are ready to mate. If the dance is successful, mating will occur.
- ▶ **Male tortoises** 'massage' the female's head, cheeks and neck with vibratory movements of their long front claws.
- ▶ Some **male eagles** perform aerobatics to impress the females. The male flies very high, dives down and somersaults during the courting ritual. If successful, the female will join him in his flight.
- ▶ The **male weaverbird** builds a nest to impress the female. When she approaches the nest, he flutters around to display his colourful wings. If the female is satisfied with the nest, she will occupy it. If she is not satisfied, she will simply ignore the male or destroy the nest.



Mating dance



Male weaverbird

Environmental changes, such as longer daylight hours, warmer temperatures or the availability of food, play a vital role in courtship as they affect hormone levels to trigger the mating season.

Many mammals e.g. antelope, have a short annual mating season. This ensures that births occur at the most favourable time - in ideal weather conditions with an abundant supply of food.

EXTERNAL VS INTERNAL FERTILISATION

- ▶ If courtship and mating are successful, fertilisation should occur.



Courtship is the behavioural patterns of male and female animals with the ultimate purpose of mating and fertilisation.

Fertilisation is the **fusing** of a haploid **male gamete (sperm)** with a haploid **female gamete (egg/ovum)** to form a diploid **zygote**.

- ▶ Two fertilisation strategies are distinguished:

- ▶ **External fertilisation**
- ▶ **Internal fertilisation**



External fertilisation

- ▶ External fertilisation takes place **outside** the female's body.
- ▶ It occurs mostly in **fish** and **amphibians** living in aquatic habitats.
- ▶ Very little cooperative behaviour is required between male and female individuals.
- ▶ Courtship and specific mating behaviour ensure that egg cells and sperm are released at the same time and place to increase the possibility of fertilisation.
- ▶ Pheromones are sometimes released by the females to attract the males.

Pheromones? *In some animal species, the females secrete chemicals known as pheromones that signal to the male that they are sexually mature.*



- ▶ Gametes (egg and sperm) are released into the water where fertilisation occurs. The water prevents gametes from drying out.
- ▶ Large numbers of gametes are produced and released to increase the chances of fertilisation and the number of offspring.
- ▶ Eggs (ova) secrete specific chemicals to attract the sperm by chemotaxis.



Chemotaxis? *The movement of a cell or organism in response to a chemical stimulus.*

- ▶ The fertilised egg cell (zygote) develops into a larva that lives on yolk or plankton. The parents do not need to expend any energy to feed the young.
- ▶ However, environmental dangers, such as predators, reduce the probability of all the offspring surviving and reaching adulthood.
- ▶ The offspring are independent and easily dispersed by water currents, causing them to settle in different areas, away from the parents to minimise competition.

In external fertilisation more energy is used to produce a large number of gametes. This increases the chances of fertilisation as many egg and sperm will be lost to predators and the environment.



Internal fertilisation

- ▶ Internal fertilisation takes place **inside** the female's body.
- ▶ It occurs mainly in **insects** and **terrestrial vertebrates** (reptiles, birds and mammals).
- ▶ This type of fertilisation does not require water and is therefore not limited to an aquatic environment.
- ▶ Fewer gametes are produced, because the possibility of fertilisation is much greater.
- ▶ During mating the sperm, in a fluid medium, are released directly into the female's body. The sperm swim to the egg to fertilise it.



Most animals in which internal fertilisation takes place, have a **penis** to transfer sperm to the female's body. This process is known as **copulation** and improves the chances of fertilisation.

- ▶ For fertilisation to occur, specific mating strategies and cooperative behaviour are required between the male and female individuals.
- ▶ Much fewer offspring are produced compared to external fertilisation.
- ▶ The following increases the chances of survival of offspring:
 - ▶ In reptiles and birds the developing embryo is nourished by the yolk and enclosed in a protective shell.
 - ▶ In mammals, the developing embryo remains inside the female where it receives protection and nutrition (from the placenta).

In internal fertilisation, less energy is expended to produce the small number of gametes. Fewer gametes, particularly eggs, are lost as they are not released externally.



OVIPARY, OVOVIVIPARY AND VIVIPARY

- ▶ Ovipary, ovovivipary and vivipary are reproduction strategies that indicate **where the embryo develops** and **how the embryo receives nutrition**.

Ovipary

- ▶ In oviparous animals the embryo develops in an egg outside the female's body.



The term **ovipary** indicates that eggs hatch outside the body.

- ▶ A distinction is made between:
 - ▶ **Oviparous aquatic animals**
 - ▶ **Oviparous terrestrial animals**

Oviparous aquatic animals (fish and amphibians)

- ▶ Fertilisation usually takes place externally in the water.
- ▶ The developing embryo is surrounded and protected by a jelly-like layer.
- ▶ Large numbers of gametes (egg cells and sperm cells) are produced which requires a lot of energy.
- ▶ Eggs with very little yolk are produced, which requires little energy.

Oviparous terrestrial animals (some reptiles, birds and primitive mammals, e.g. the platypus and spiny anteater)

- ▶ Fertilisation usually takes place internally.
- ▶ The developing embryo is surrounded by a shell that protects it against dehydration.
- ▶ Fewer gametes are produced by the female which requires much less energy.
- ▶ However, the production of eggs with shells and a large quantity of yolk requires a lot of energy.



Platypus

Ovovivipary (some sharks, lizards and snakes)

The term **ovovivipary** indicates that eggs hatch inside the body.



- ▶ Internal fertilisation takes place.
- ▶ The embryo is surrounded by a thin, membranous shell inside the female's body.
- ▶ The developing embryo receives nutrition from the large quantity of yolk stored in the egg.
- ▶ The egg is laid as soon as the embryo is fully developed and ready to hatch.
- ▶ Shortly afterwards the newborn breaks through the soft membrane, hence the term **ovovivipary**.



NB: There is no physical connection between the mother and the developing embryo.

- ▶ The female produces few eggs, which requires less energy.
- ▶ Since the embryo develops in an egg with a shell, inside the female, it is protected against predators and unfavourable temperatures.

Vivipary (most mammals, certain sharks and scorpions)

The term **vivipary** indicates that the young are born live.



- ▶ Internal fertilisation takes place.
- ▶ The fertilised egg develops into an embryo without the protection of a shell.
- ▶ The embryo/foetus is directly connected to the mother as it receives nutrients through the placenta which consists of embryonic and maternal tissues.



What is the difference between an embryo and a foetus?

The **embryo** develops during the first stages of development after the formation of the zygote. As soon as the tissues have differentiated into organs, it is known as a **foetus**.

- ▶ The female produces few gametes, requiring less energy.
- ▶ Parental care (the feeding and protection of the developing embryo and foetus) however, requires large quantities of energy.

AMNIOTIC EGG

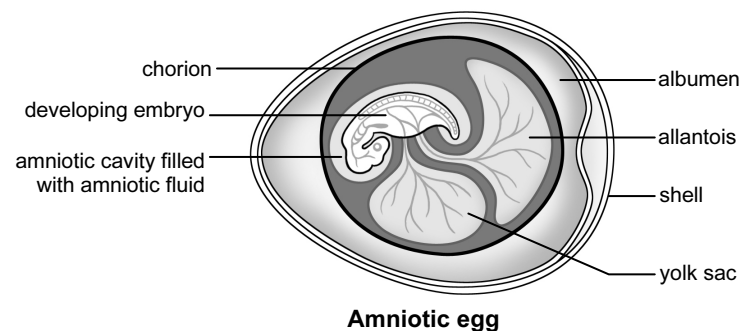
- ▶ Fish and amphibians need water for fertilisation and for the development of their eggs.
- ▶ Terrestrial (land) animals like some reptiles, birds and mammals, require specialised structures to protect the developing embryo from desiccation (drying out).
- ▶ **Amniotic eggs** are adapted for terrestrial life (life on land).
- ▶ After internal fertilisation, the embryos are enclosed in an egg with a hard shell.
- ▶ These eggs develop **extra-embryonic membranes** filled with fluid.



Extra-embryonic membranes? The membranes that occur outside the embryo.



- ▶ The amniotic egg prevents dehydration of the embryo and provides nutrients, water and oxygen to the embryo while waste products are removed.

Structure of an amniotic egg

The amniotic egg consists of:

- ▶ The **developing embryo**
- ▶ **Three extra-embryonic membranes:**
 - ▶ A fluid-filled **amnion** surrounds the embryo and protects it against shocks, injuries, temperature changes and dehydration.
 - ▶ The **allantois** is a sac that grows from the embryo's intestines, collects waste products and exchanges gases.

- The **chorion** is the outermost membrane that surrounds all the membranes.
 - In birds and reptiles it allows gaseous exchange, together with the porous shell.
 - In mammals it forms part of the placenta, which supplies the embryo/foetus with nutrients and also allows for gaseous exchange and excretion.
- The **yolk sac**, filled with energy-rich yolk, provides food for the developing embryos.
- The **albumen**, between the chorion and the shell, serves as reserve food (protein and water).
- The hard, calcareous or leathery **shell** is porous to allow gaseous exchange. It also protects the developing embryo and prevents dehydration.

PARENTAL CARE

- Parental care is any behavioural pattern where parents spend time and/or energy on the feeding and protection of their offspring.
- In animals where most of the energy input of parents is prenatal, there is usually very little or no postnatal parental care.
- In animals where prenatal energy input is less, postnatal parental care is intensive, requiring much more energy.



In animals where good parental care occurs, fewer young are usually produced, because their chance of survival is much better.

‣ Examples of parental care include:

- guarding of eggs
- incubation of eggs
- keeping the young warm
- feeding the young
- protection from predators



Different groups of animals display varying degrees of parental care.



Fish

- Most fish display little or no parental care.
- After fertilisation the eggs are abandoned and the young have to survive on their own.

Amphibians

- Amphibians show little parental care.
- Parental care involves only the guarding and protection of the eggs.

Reptiles

- Most reptiles display no parental care.
- Reptiles are terrestrial animals and lay eggs that are hatched by the heat of the sun.
- Crocodiles, however, guard their eggs and protect their young after hatching. Some lizards and snakes also guard their eggs.



Birds

- Birds display a great degree of parental care.
- The parents build nests in which the eggs are laid and incubated. The nest helps to protect the eggs against predators.
- The eggs are incubated through the body heat of the parents. In most birds, it is the female who incubates the eggs.
- Chicks of precocial bird species, that are immediately active and leave the nest shortly after hatching, receive parental care, including:
 - body heat from parents, which helps to regulate the body temperature of the chicks.
 - parental guidance to find food.
 - parental training to avoid predators and teach protection strategies.
- Chicks of altricial bird species, who are not active immediately after hatching and stay in the nest for a long time, receive parental care, including:
 - body heat from parents, which helps to regulate the body temperature of the chicks.
 - food from parents.
 - protection against predators.

Mammals

- ▶ Mammals display the highest degree of parental care. Most mammals are totally helpless after birth, and completely dependent on parental care.



The large degree of parental care in mammals increases their chances of survival to reproductive age.

- ▶ After birth, the young receive milk from the mother's mammary glands.
- ▶ The young are kept warm by the body heat of the parents, helping them to regulate their body temperature.
- ▶ The parents protect the young from predators.
- ▶ The parents teach behavioural patterns so that the young can function independently, e.g. how and where to find food.

With regard to humans, parental care also includes the support of children's emotional, social and intellectual development until they reach maturity.

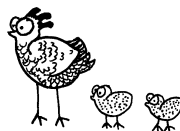


PRECOCIAL AND ALTRICIAL DEVELOPMENT - enrichment



Precocial and altricial are terms describing the extent of development of the embryo when it is hatched or born.

- ▶ These two **developmental strategies** occur mainly in **birds** and **mammals** and are related to their environment.
- ▶ It relates to:
 - ▶ **food supply** for the developing embryos and offspring, as well as
 - ▶ **protection** against predators



Precocial development

- ▶ Precocial refers to species where the young are practically fully developed and immediately mobile when they are hatched/born.
- ▶ In general, few offspring are produced, as each individual has to develop to a relatively advanced stage before it is born or hatched.
- ▶ In precocial animals, most of the energy is expended on prenatal development. The mothers are far less involved after the young are born or hatched.

Birds

- ▶ Examples include birds nesting on the ground, such as chickens, ducks, geese, guinea fowls and ostriches.
- ▶ The incubation time is usually long so that the young can complete their development before hatching.
- ▶ The eggs contain a large amount of yolk and albumen so that there are sufficient food reserves for the extended incubation period.
- ▶ The chicks' eyes are open directly after hatching.
- ▶ The chicks' bodies are covered with downy feathers, soon to be replaced by adult feathers.
- ▶ Many chicks, however, cannot regulate their own body temperature yet and are still dependent on their parents' body heat.
- ▶ The chicks are immediately active and leave the nest soon after hatching.
- ▶ The chicks can, often with the help of the parents, find their own food.
- ▶ The chicks can attempt to protect themselves against predators by means of camouflage, by remaining flat and motionless on the ground or by running away.



Mammals

- ▶ Examples include most ungulates, such as cattle, sheep, antelope, giraffes, zebra, wildebeest, rhinoceros and hippopotamus, as well as most hare species.
- ▶ The gestation period is long, allowing enough time for the young to reach full development.
- ▶ The embryo/foetus receives nutrients from the placenta during the long gestation period.
- ▶ The eyes of the young open directly after birth.
- ▶ The young are covered in hair.
- ▶ The young are immediately active, they can stand and start walking within a few hours of birth.
- ▶ The young can regulate their own body temperature.
- ▶ The young can feed themselves and drink the mother's milk.
- ▶ The young can attempt to protect themselves from predators by means of camouflage, by lying flat and motionless or by running away.



Precocial mammals

The young of precocial animals have a very good chance of surviving to reproductive age, since they are independent and can look after themselves from a young age.

Altricial development

- ▶ Altricial refers to species where the young are not fully developed and cannot move around immediately after being born or hatched.
- ▶ In general, more offspring are produced and the young are born or hatched at an early stage.

Humans are an exception as they have few offspring.



- ▶ Altricial animals spend most of their energy on postnatal development. The parents are involved in feeding the young and protecting them against predators for a long time after birth.

Birds

- ▶ Examples include birds nesting above ground (e.g. in trees), such as doves, weaver birds, eagles and falcons.
- ▶ The incubation period is shorter since birds sitting on their nests for long periods of time are more vulnerable to predation. The young hatch as soon as possible.
- ▶ The eggs are smaller than those of precocial species and contain little yolk.
- ▶ The chicks' eyes are often still closed after hatching.
- ▶ The chicks have naked bodies, without a downy feather covering.
- ▶ The chicks cannot regulate their body temperature and are still dependent on their parents' body heat.
- ▶ The chicks cannot walk or fly.
- ▶ The chicks remain in the nests for a long period of time and are totally dependent on the parents for food.
- ▶ The parents protect the defenceless chicks against predators.



Mammals

- ▶ Examples include rodents (e.g. rats and mice); cats (e.g. domestic cats, lions, cheetahs and the rookiat); dogs; marsupials (e.g. kangaroos, wallabies and koalas) and primates (apes and baboons).

Humans are also an altricial species since a significantly long period of time elapses before adulthood.



- ▶ Since pregnant females are very vulnerable to predation, the young are born as soon as possible.
- ▶ The eyes of the young are often still closed after birth.
- ▶ The bodies of the young are often hairless.
- ▶ The young are not immediately active after birth and sometimes they cannot walk.
- ▶ The young cannot regulate their body temperature and are still dependent on the body heat of their parents.
- ▶ The young cannot feed themselves and depend on the parents for food.
- ▶ The young are helpless and are completely dependent on their parents for protection from predators.



Altricial mammals

A significant number of offspring from altricial animals will survive to reproductive age because:

- ▶ they have high parental care (they are fed, kept warm, protected against predators).
- ▶ their nests are often protected from predators, and they only leave the nest once they can fend for themselves and protect themselves.

