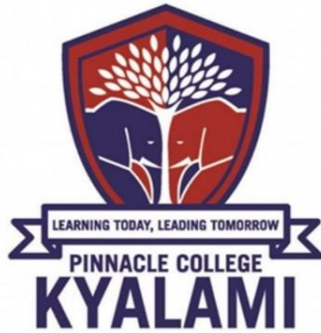




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**GRADE 12
LIFE SCIENCES
PRELIMINARY EXAMINATION
PAPER 2**

**SOURCE MATERIAL BOOKLET FOR
QUESTIONS 1, 2 AND 3**

SECTION A

QUESTION 1

Read the information below. Refer to this information, as well as your own knowledge, to answer Question 1 in the question paper.

1. Mutualistic relationships between plants and animals.

Plants have developed mutualistic relationships with animals to help them successfully pollinate. There are two main ways plants pollinate: wind pollination and animal pollination. Plants such as grasses that live in open areas with lots of wind will utilize wind pollination. To overcome the disadvantages of wind pollination, many plants depend on animals for their pollination. Some plants are pollinated by birds, such as the hummingbird. A small number of plants are pollinated by rats. The vast majority of plants, by far, are pollinated by insects.

Angiosperms use bright, colourful flowers to attract bees, flies, butterflies, and moths in order for them to collect nectar and pollen. Some flowers have developed lines on their petals that guide the insects down into the blossom. Other flowers have developed sweet smells that attract pollinators from far away.

The colour of the flower and its scent will attract specific types of insects. Bees are attracted to yellow, blue, and purple flowers with a sweet, fresh scent. Butterflies prefer red, yellow and blue flowers. Moths focus on colours that are more visible at night, such as white or pale green flowers with a strong, sweet scent. Brown, purple or dull flowers with strong, fruity smells attract beetles. Flies prefer purple or brown flowers that smell like decaying flesh.

The insect's reward is fairly consistent: they are provided nectar and/or pollen by the plant.

Adapted from: [<https://www.plt.org/educator-tips/mutualistic-relationships>]

2. Sugarbirds in the Cape.

Sugarbirds are dependent on Protea and are found in protea scrub. The Cape Sugarbird is found in fynbos and has also moved into gardens and nurseries.



[Figure 1.1]

There are two species of sugarbird. Both have long and slender bills that are slightly curved, and the females have a slightly shorter bill, leading to differences in feeding niches. The skull and tongue morphology of the sugarbirds is very similar to that of the honeyeaters, the result of convergent evolution. The tongue is long and protrusible, and is tubular and frilled at the end.

Nectar from the inflorescences of the Protea provide most of the energy these species require, and they are considered significant pollinators of the genus. The birds' diet is supplemented by insects attracted to the inflorescences.

The breeding behaviour and nesting habits of the two species of sugarbird are very similar. They are typically monogamous, and male sugarbirds defend territories during the breeding season. Females lay two eggs in a nest in a fork of a tree.

[Adapted from: <https://fatbirder.com/ornithology/promeropidae-sugarbirds/>]

3. The structure of the protea flower.

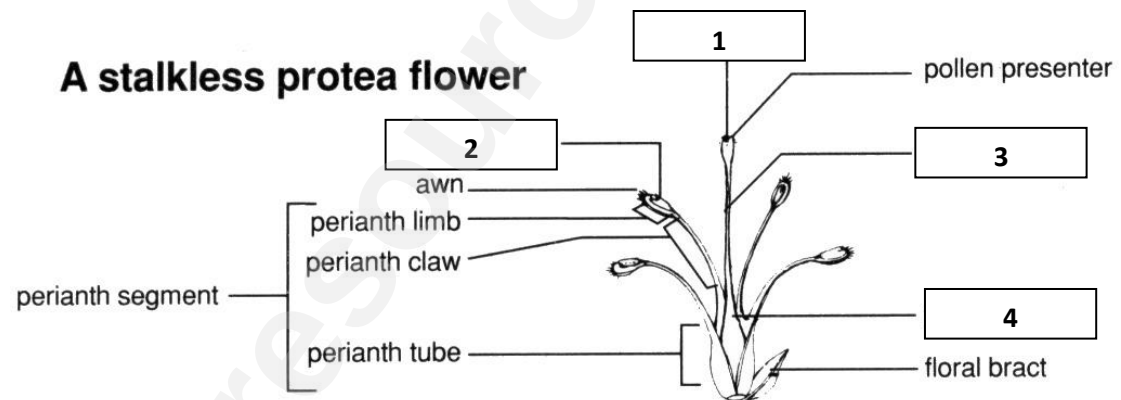
The classification of plants is based largely on the shape of flowers and the protea flower must rank as one of the easiest to identify.

The secret is to ensure that you are looking at a flower, and not the flowerhead - which is composed of many flowers together with some colourful bracts. It is a feature of southern African proteas, together with daisies, that the flowers are grouped into large heads which many mistake for flowers.



[Figure 1.2]

https://img.peapix.com/5349012671547613668_UHD.jpg



[Figure 1.3]

[Adapted from: <https://www.proteaatlas.org.za/flowerh.htm>]

4. Reproductive strategies of the Cape Sugarbird.

Sexual dimorphism usually arises through sexual selection— defined by Darwin to be selection that operates through the ability of members of one sex (usually males) to gain access to the members of the opposite sex for the purposes of mating. Male sugarbirds are the more ornamented sex (i.e. they have beautiful tail feathers).



[Figure 1.4] - <https://images.squarespace-cdn.com/content/v1/58b3f7f5e58c62561f62dc27/83c6c02d-25b8-4c8b-81bf-01323c104e19/cape+sugarbird>

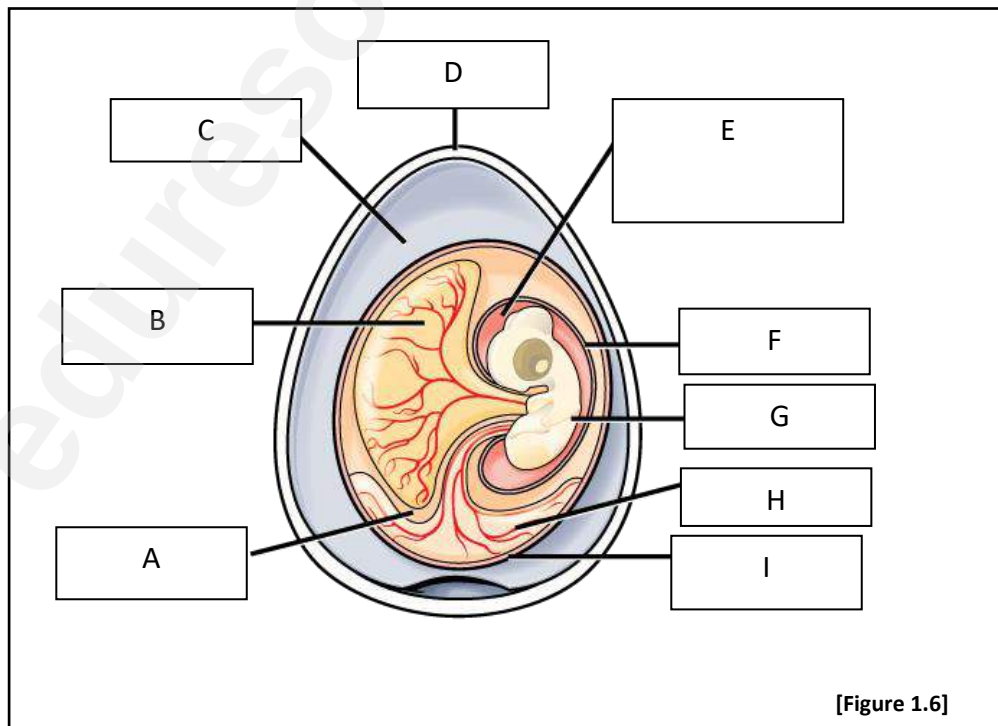


[Figure 1.5] - <https://www.warwicktarboton.co.za/images/BIKD%20jpls/resized/773-Cape-Sugarbird-b.jpg>

It has been found that Cape Sugarbirds make use of “social monogamy”, choosing a mate for life. However, the males that are selected as life-long mates often help raise offspring that are not genetically theirs. This is referred to as extrapair paternity and genetic polygamy.

[Information adapted from a study published in Behavioral Ecology. Long tails matter in sugarbirds— positively for extrapair but negatively for within-pair fertilization success, McFarlane, et al. Vol 21, Issue 1, Jan 2010]

5. Structure of an amniotic egg



[Figure 1.6]

[Adapted from: https://s3-us-west-2.amazonaws.com/courses-images/wp-content/uploads/sites/1223/2017/02/06212753/Figure_29_04_01.png]

QUESTION 2

Read the information below. Refer to this information, as well as your own knowledge, to answer Question 2 in the question paper.

1. Fertilization

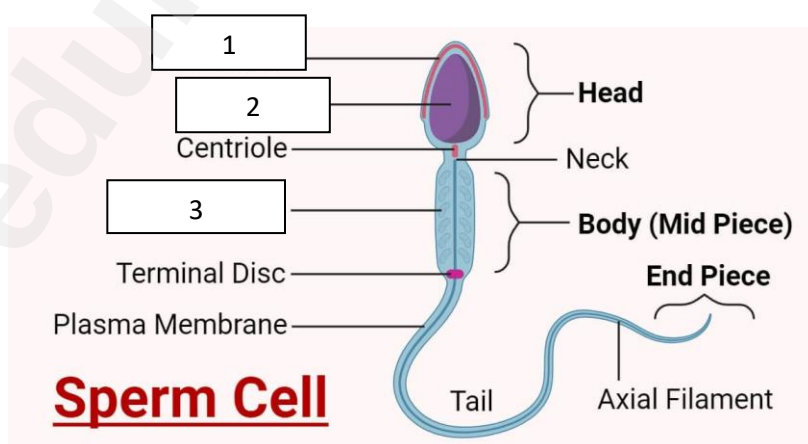
The meeting and resulting fusion of sperm and egg deserves to be called the “miracle of conception” – only one in a million human sperm cells gets near the egg. To beat these overwhelming odds, animals have strategies that help bring the two reproductive cells together.

For internal fertilization, at least in mammals, sperm are guided through rheotaxis – movement through a fluid. This was discovered in 2013 by Kiyoshi Miki and David Clapham, who saw that human and mouse sperm travel against the flow, like salmon swimming upstream. Sexual intercourse stimulates the oviduct’s walls to secrete fluids that push mucus and debris out of the way, clearing a path for sperm and offering them a cue for where to go. Rheotaxis drives natural selection between sperm, because only the strongest swimmers survive.

[Adapted from: 50 ideas you really need to know. Biology. JV Chamary. Quercus, Great Britain, 2015.]

2. Rheotaxis

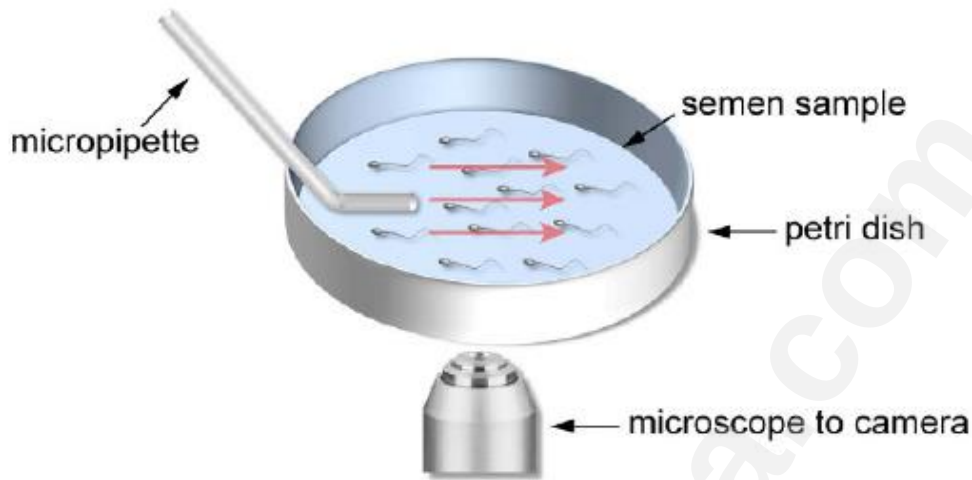
A long-standing question in natural reproduction is how mammalian sperm navigate inside female reproductive tract and finally reach the egg cell, or oocyte. Recently, fluid flow was proposed as a long-range guidance cue for sperm navigation. Sexual intercourse induces fluid flow from oviduct to uterus, and sperm align themselves against the flow direction and swim upstream, a phenomenon termed rheotaxis. Sperm cells also make use of chemotaxis (sperm are attracted by chemo-attractants secreted by oocyte and its surrounding cells and swim against the chemical gradient) as well as thermotaxis (sperm swim against temperature gradient in oviduct to find the egg).



[Figure 2.1]

[Adapted from: <https://microbenotes.com/wp-content/uploads/2024/04/Anatomy-and-Structure-of-Sperm-Cell.jpeg>]

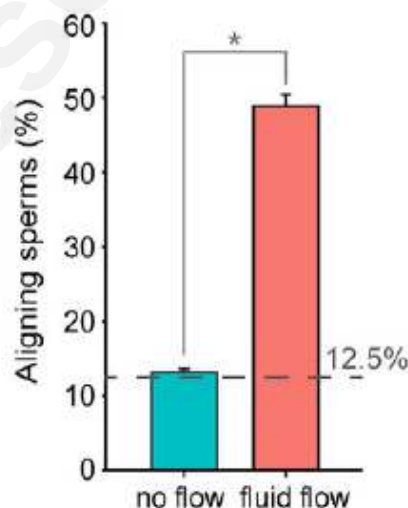
An investigation was carried out to determine whether sperm cells would redirect their swimming direction according to the direction of flow.



[Figure 2.2]

Sperm cells were placed in a petri dish, as shown in Figure 2.2 above. A micropipette was placed on the petri dish bottom to generate fluid flow.

Without fluid flow, sperm swam in random directions with largely linear trajectories. However, when fluid flow was introduced, the sperm swam against the artificially generated fluid flow, and curved trajectories were observed, indicating that sperm adjusted their moving directions and gradually aligned against the flow. The results can be seen in the graph below.



[Figure 2.3]

[Adapted from a study published in Scientific Reports. Human sperm rheotaxis: a passive physical process. Z. Zhang, et al. March 2016]

3. In vitro fertilization (IVF)

British physiologist Robert Edwards spent over two decades trying to get human sperm to fertilize eggs inside a Petri dish, or *in vitro* (Latin for “in glass”). But then he teamed up with gynaecologist Patrick Steptoe, who used laparoscopic surgery to extract eggs from ovaries.

The pair monitored natural menstrual cycles to identify time of ovulation, at which point the single egg was collected, fertilized and implanted into a prospective mother’s uterus. The first “test-tube baby”, Louise Brown, was born on 27 July 1978. Since then, almost six million children have been conceived through IVF.

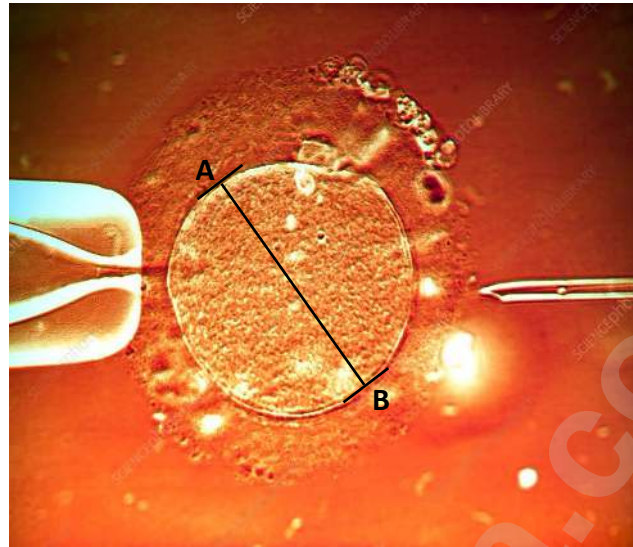
[Adapted from: 50 ideas you really need to know. Biology. JV Chamary. Quercus, Great Britain, 2015.]



[Figure 2.4]

[Adapted from presentation - Advanced Reproductive Technologies, Dr.Yvonne Holt, 2024]

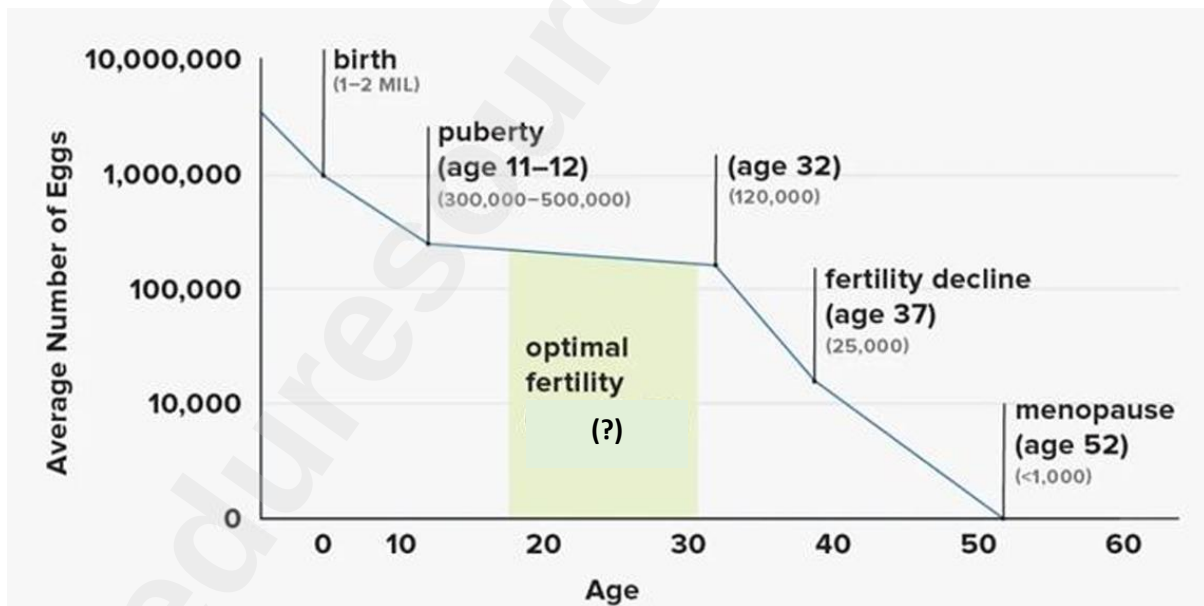
4. Micrograph - In vitro fertilization.



[Figure 2.5]

[Adapted from: <https://media.sciencephoto.com/image/f0011536/800wm>]

5. How many eggs do human females have?



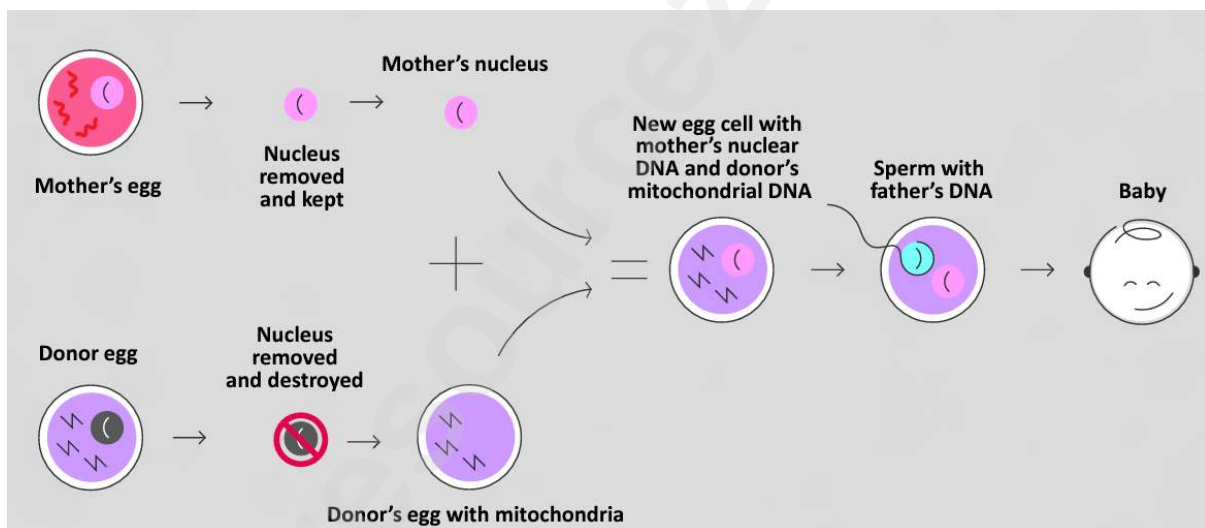
[Figure 2.6]

[Adapted from presentation - Advanced Reproductive Technologies, Dr.Yvonne Holt, 2024]

6. Three-person babies

Arguably the biggest – and most controversial – development over the past three decades has been so called “three-person babies”. In 2015, the British government approved a law that allows the nucleus of from one woman’s egg to be transferred into an egg donated by another individual. While the second cell would have no nucleus, its cytoplasm contains mitochondria, which have their own DNA. Mitochondria carries 37 genes whereas nuclear chromosomes include 20 000. A fertilized egg would technically inherit genetic material from three “parents” (although one only contributes less than 0.2% of genes.) A child born through this technique could avoid defects in mitochondria that can cause disease.

[Adapted from: 50 ideas you really need to know. Biology. JV Chamary. Quercus, Great Britain, 2015.]



[Figure 2.7]

[Adapted from presentation - Advanced Reproductive Technologies, Dr.Yvonne Holt, 2024]

SECTION B

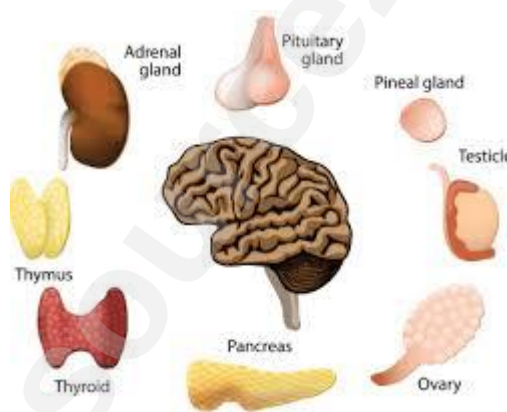
QUESTION 3

Read the information below. Refer to this information, as well as your own knowledge, to answer Question 3 in the question paper.

SOURCE A

Hormones are chemicals that coordinate different functions in your body by carrying messages through your blood to your organs, skin, muscles and other tissues. These signals tell your body what to do and when to do it. Hormones are essential for life and your health. Scientists have identified over 50 hormones in the human body so far.

Hormones and most of the glands that create and release them make up your endocrine system. Hormones control many different bodily processes, including: metabolism, homeostasis (constant internal balance), growth and development, sexual function, reproduction, sleep-wake cycle and mood.



Hormone imbalances can lead to problems like: irregular menstruation (periods), infertility, acne, diabetes, thyroid disease, obesity and anxiety.

Some chronic illnesses may be a result of hormone imbalances. These imbalances are often caused by tumours, damage to endocrine glands and autoimmune conditions.

Treatment for a hormonal imbalance will depend on what's causing it. If you have lower-than-normal hormone levels, the main treatment is hormone replacement therapy. Depending on which hormone is deficient, you may take oral medication (pills) or injection medication.

For example, if you have low thyroid hormone levels (hypothyroidism), your provider can prescribe synthetic thyroid hormone pills. If you have growth hormone deficiency, you'll likely have to take injections (shots) of synthetic growth hormone.

Many health conditions that involve hormonal imbalances, such as diabetes and thyroid disease, require medical treatment.

Many nutritional supplements in stores claim to treat different hormonal imbalances, but few of them have been scientifically proven to have a beneficial effect. It's important to always talk to your healthcare provider first about taking supplements.

Aside from medical treatment, your provider may recommend certain lifestyle changes to help manage a hormonal imbalance, such as managing your stress levels and getting routine exercise.

[Adapted from: <https://my.clevelandclinic.org/health/diseases/22673-hormonal-imbalance>]

SOURCE B HORMONE REPLACEMENT THERAPY

Hormone therapy was once routinely used to treat menopausal symptoms and protect long-term health. Then large clinical trials showed health risks.

Hormone replacement therapy is medication that contains female hormones. You take the medication to replace the oestrogen that your body stops making during menopause. Hormone therapy is most often used to treat common menopausal symptoms, including hot flashes and vaginal discomfort. Hormone therapy has also been proven to prevent bone loss and reduce bone fractures in postmenopausal women.

However, there are risks associated with using hormone therapy. These risks depend on the type of hormone therapy, the dose, how long the medication is taken and your individual health risks. For best results, hormone therapy should be tailored to each person and re-evaluated every so often to be sure the benefits still outweigh the risks.

In the largest clinical trial to date, hormone replacement therapy (that consisted of an oestrogen-progestin pill) increased the risk of certain serious conditions, including:

- Heart disease
- Stroke
- Blood clots
- Breast cancer

You may be able to manage menopausal hot flashes with healthy-lifestyle approaches such as keeping cool, limiting caffeinated beverages and alcohol, and practicing paced relaxed breathing or other relaxation techniques. For vaginal concerns such as dryness or painful intercourse, a vaginal moisturizer or lubricant may provide relief. There are also several non-hormone prescription medications that may help relieve hot flashes, as well as vaginal discomfort.

[Adapted from <https://www.mayoclinic.org/diseases-conditions/menopause/in-depth/hormone-therapy>]:

Hormonal Imbalance Treatments

Lifestyle Changes

- Diet
- Exercise
- Stress-relief
- Addiction control



Alternative Medicine

- Natural supplements
 - Nutritional
 - Phytoestrogenic
 - Hormone-balancing
- Alternative therapies
 - Acupuncture
 - Aromatherapy



Conventional Medicine

- Medications
 - Disease-specific
 - Oral contraceptives
 - HRT
- Surgery
 - Only for symptom relief



Because symptoms of hormone imbalance can wreak havoc in the female body, choosing **quick and adequate treatment** from among three approaches is of the utmost importance.

[<https://www.shecares.com/hormones/treatments>]

As you get older, the hormones begin to change in your body. If you have diabetes, this can potentially affect your blood sugar levels.

There are many changes that happen in your body as you get older, which may affect how active you are in your everyday life. With a lower level of activity, you are more likely to gain weight, which can affect your blood sugar levels. Your body also doesn't use insulin as efficiently as it did in your younger years.

You also start to produce fewer hormones as you age. This can cause a hormonal imbalance in both men and women. Men create less testosterone and women create less oestrogen and progesterone. These changes can potentially spike your blood sugar.

If your blood sugar gets too out of control and you are unable to manage it, you may need to start hormone replacement therapy.

[<https://www.bassmedicalgroup.com/blog-post/hormonal-imbalance-in-diabetics-know-your-treatment-options>]

SOURCE C

STEROIDS ARE HORMONES

Steroids, also called corticosteroids, are anti-inflammatory medicines used to treat a range of conditions.

They're different from anabolic steroids, which are often used illegally by some people to increase their muscle mass.

Doctors may prescribe steroids in the form of: tablets, liquids, inhalers, nasal sprays, injections, creams, lotions and gels.

Most steroids are only available on prescription, but a few (such as some creams or nasal sprays) can be bought from pharmacies and shops.

Side effects of steroids

Steroids do not tend to cause significant side effects if they're taken for a short time or at a low dose.

But sometimes they can cause unpleasant side effects, such as an increased appetite, mood changes and difficulty sleeping (insomnia). This is most common with steroid tablets.

The side effects will usually pass once you finish the treatment, but patients should not stop taking their medicine without speaking to their doctor. A doctor will properly advise a patient on how to gradually reduce the dose if necessary. Stopping a prescribed course of medicine suddenly can cause further unpleasant side effects (withdrawal symptoms).

[Adapted from: <https://www.nhs.uk/conditions/steroids/>]

SOURCE D

HORMONES AND GENDER-AFFIRMING CARE.

Extensive studies have found that gender-affirming care benefits the mental health of young transgender individuals. Researchers, practitioners and students at a number of tertiary institutions have been working to document the importance of holistic and inclusive health care services for transgender and nonbinary people.

A study published in JAMA Network Open by first-author Diana Tordoff, a Ph.D. graduate of the Department of Epidemiology, shows that access to puberty blockers and gender-affirming hormone therapy mitigates negative mental health outcomes.

The study — led by senior authors Drs. Kym Ahrens and David Inwards-Breland at Seattle Children's Gender Clinic — found that having access to hormones and puberty blockers for youth ages 13 to 20 was associated with a 60% lower odds of moderate to severe depression and a 73% lower odds of self-harm or suicidal thoughts compared to youth who did not receive these medications over a 12-month period.

[Adapted from: <https://sph.washington.edu/news-events/sph-blog/benefits-gender-affirming-care>]

SOURCE E

STEROIDS AND SPORT

Erythropoietin (EPO) has been used by athletes to stimulate the bone marrow to produce more red blood cells. This enables more oxygen to be carried.

There are other legal ways to increase the number of red blood cells. EPO is a hormone produced in response to anaemia, haemorrhage, pregnancy, or living at high altitudes where there is less oxygen. More recently, hypoxic air machines have been used to simulate altitude training. The body responds by releasing natural EPO and growing more red blood cells, so that it can absorb more oxygen with every breath.

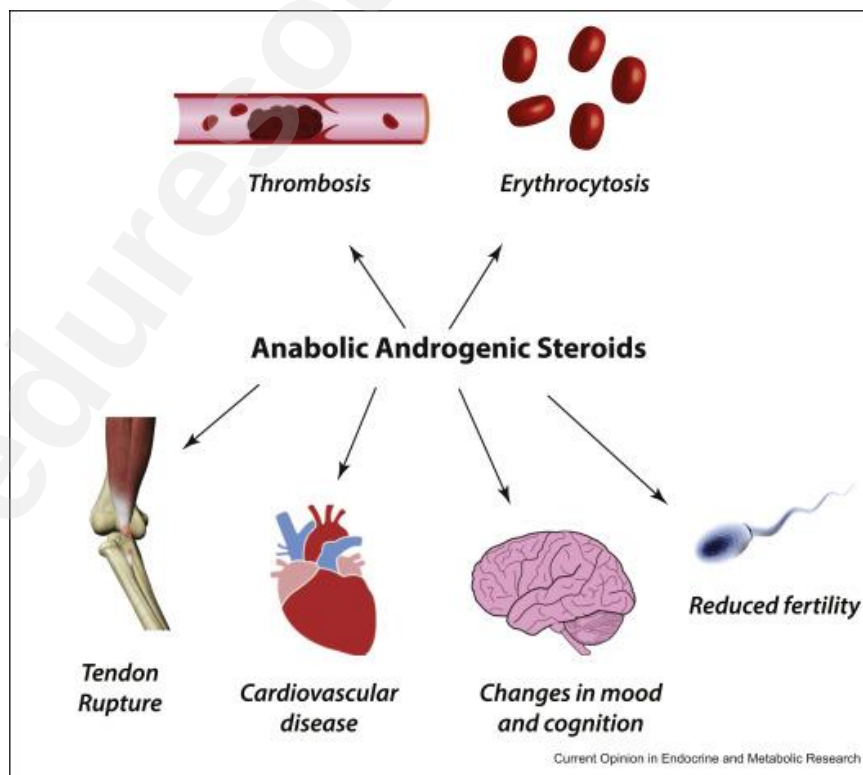
Unfortunately, not everyone can afford hypoxic air machines and altitude training. These individuals are “forced” to use EPO because of this.

Some people feel that there is ethically no difference between elevating your red blood cell count by altitude training, by using a hypoxic air machine, or by taking EPO. They all increase performance in essentially the same way – increasing the number of red blood cells.

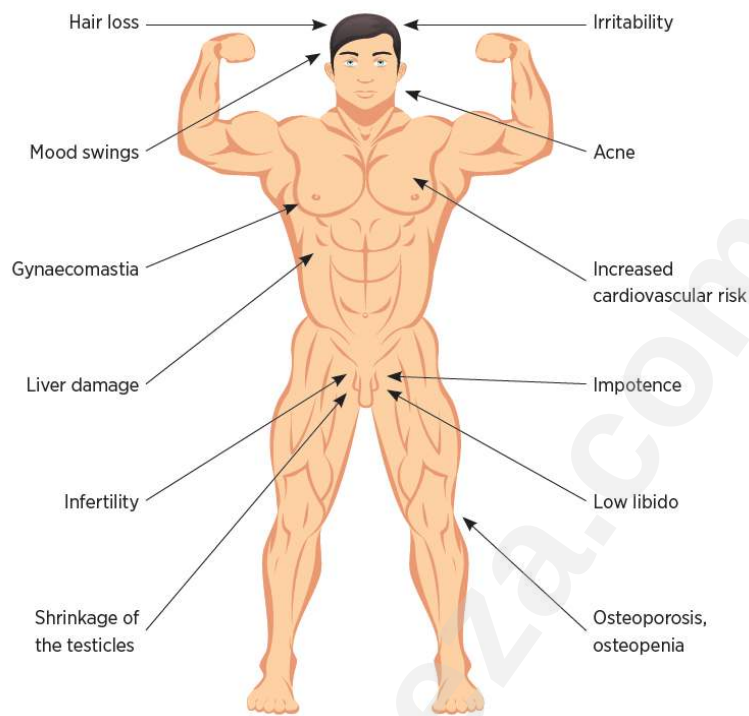
However, it must be noted that scientists have found that raising the number of red blood cells in your body can cause health problems such as risk of stroke or heart attack.

Many other steroids (growth hormone, testosterone, etc.) are also used by athletes to increase performance, but these have their own negative side effects.

[Adapted from: IEB, Supplementary Paper II, May 2021]



[<https://ars.els-cdn.com/content/image/1-s2.0-S2451965019300912-gr1.jpg>]



[<https://australianprescriber.tg.org.au/assets/ee2d6d15217e5b20-2c7e39f2e6ac-Fig-androgenic-adverse-effects-in-men.PNG>]

SOURCE F

IVF HORMONES

Whilst IVF has successfully allowed couples who were previously unable to have children to have their own biological offspring, not all people have access to this kind of health care.

IVF is expensive, and thus not accessible to everyone.

The approximate cost of IVF is R 73 000. This excludes the cost of medication (hormones) during treatment, which can range between R 12 000 - R 15 000. Additional costs that could apply includes: donor eggs, donor sperm and freezing of additional embryos.

Hormones for IVF are extremely important because they help control the treatment and maximize the patient's chance of successful pregnancy. Because the menstrual cycle of the woman receiving treatment must be adjusted for timely egg maturing and egg retrieval, the IVF hormones fertility doctor prescribes help regulate the cycle. The reproductive system is a complex one — it involves various hormones, each of which affects the woman's ability to conceive and get pregnant. Hormones like AMH (Anti-mullerian hormone), LH, FSH, progesterone, oestrogen, prolactin and TSH play a huge role in female reproductive health and hence, the process of IVF.

[Adapted from: <https://aevitasfertilityclinic.co.za/Fertility-Treatment>]

Fertility Pills & Injections

Fertility medications, which can come as pills and injections, are used to **stimulate ovulation** as a part of infertility treatment or fertility preservation.

PILLS	INJECTIONS	
● Clomiphene citrate ● Letrozole ● Metformin ● Bromocriptine 	● Human menopausal gonadotropin ● Gonadotropin-releasing hormone ● Follicle-stimulating hormone 	
SUCCESS RATES	RISKS & SIDE EFFECTS	COST
 ● Fertility pills: up to 23% pregnancy rate ● Fertility injections: up to 32% pregnancy rate	 ● Higher risk of multiple pregnancies ● Ovarian hyperstimulation syndrome (OHSS) ● Ectopic pregnancy	 ● Fertility pills: \$10 - \$100/cycle ● Fertility injections: \$1,000 - \$6,000/cycle

www.shecares.com

(Note: This is equivalent to roughly R18 000 – R107 000)

[<https://www.shecares.com/imgs/4/0/e/213997/fertility-pills-amp-injections.png>]

SOURCE G

HORMONES IN FOOD

Public concern over the safety of South African meat and meat products which might contain hormones has increased, particularly since the use of hormones in meat production is not permitted in Europe. Some of the health problems being raised are low sperm counts in men, boys developing breasts and early onset of puberty in girls.

The fact is, for decades in South Africa, almost all abattoir meat has been produced with the aid of hormones, and it is known to be a completely safe practice.

Bovines (cattle, etc) normally produce their own sex and other hormones and over thousands of years, humans have eaten meat and have suffered no ill effects. Difficult farming conditions in South Africa mean that it is necessary to use all possible methods to maximise the efficiency of our agricultural industry, in conditions that are safe for both humans and animals.

The following table shows the sex hormone contents of a selection of foods in micrograms (μg) per 500 g food, from the highest to the lowest.

(As a comparison: birth-control pills contain between 30 to 350 μg hormone per unit, which means we can say that about 30 μg is the minimum dose for causing any changes or having any physiological effects on the human body.)

Beer made from hops	0.078 $\mu\text{g}/500\text{g}$
Peas	2 $\mu\text{g}/500\text{g}$
Eggs	7.5 $\mu\text{g}/500\text{g}$
Ice cream	3 $\mu\text{g}/500\text{g}$
Milk	0.065 $\mu\text{g}/500\text{g}$
Beef from steers – implanted cattle	0.007 $\mu\text{g}/500\text{g}$
Beef from steers – non-implanted cattle	0.005 $\mu\text{g}/500\text{g}$

So we can see that a pint of beer (or a helping of peas or ice cream!) will provide more sex hormones than a 500g steak, but none are enough to produce any physiological effect whatsoever.

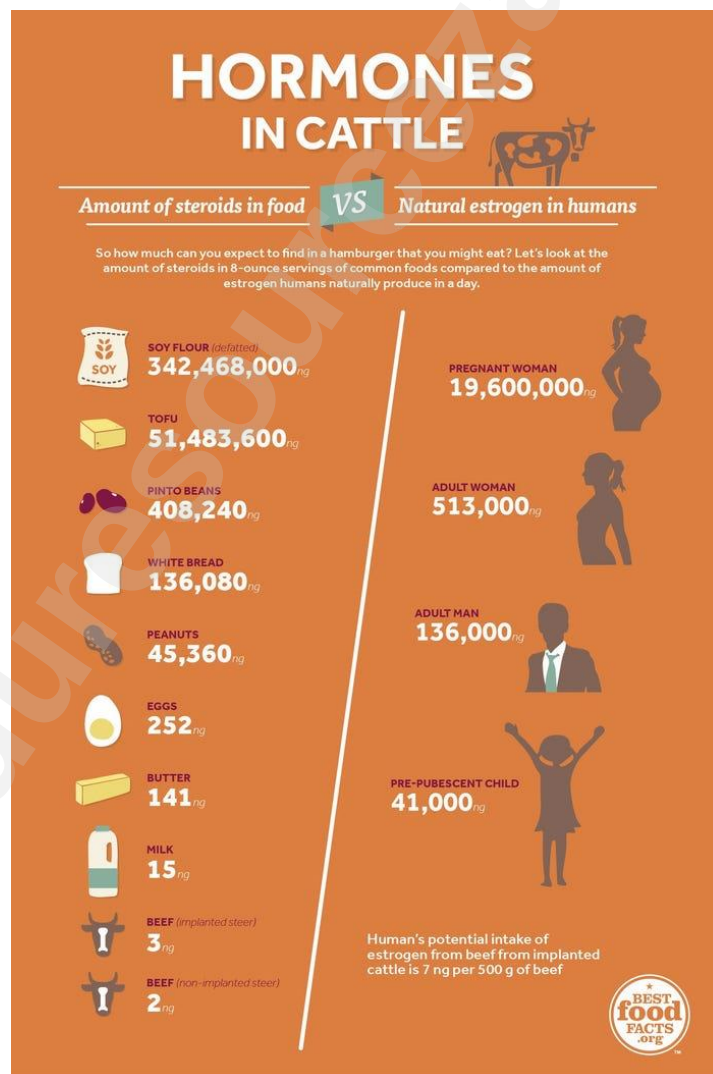
Looking at it another way, a person would have to eat about 4 280kg of beef or 15g of soybean oil every day, to consume enough hormone to have any effect on the human body.

There are four anabolic steroids (hormones) commonly used in promoting the growth of animals:

- estradiol and progesterone, which are the naturally occurring hormones;
- zeranol and trenbalone, which are the synthetics.

When used as recommended, these hormones are extremely safe for both the animal and the final consumer and residues are really negligible.

[Adapted from: <https://foodfacts.org.za/hormones-in-meat/>]



[<https://www.beefmagazine.com/policy/hormones-by-the-numbers-stats-to-share-with-consumers>]