NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2021

LIFE SCIENCES: PAPER II

SOURCE MATERIAL BOOKLET FOR QUESTIONS 1, 2 AND 3

SECTION A

QUESTION 1

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

Commercial Orchid Production

The beauty, complexity and incredible diversity of orchid flowers is unrivalled in the plant world. For centuries, orchids have held a fascination for people. There is an air of mystery surrounding them, resulting from the huge variety of strange flower shapes, colours and fragrances. With an estimated 750 different genera with at least 25 000 – 30 000 species worldwide and at least 200 000 hybrids, it is probably the largest family in the plant kingdom.

Figure 1 – A variety of orchids of the genus *Phalaenopsis*

[<https://www.static.wixstatic.com>]

Orchids of the genus *Phalaenopsis* have high economic value both as pot plants and for cut flowers. These are the orchids that everyone sees for sale in nurseries and grocery stores throughout the country. There are two ways of producing these plants commercially – through sexual as well as asexual means.

[Adapted: <https://www.gardeners.com>]

Seed raised orchids

The process of creating a new orchid hybrid starts with the selection of two parent orchid plants with favourable characteristics. Orchids are bisexual. Therefore, each flower has both stamens and stigmas. Cross-pollination is carried out and the seeds that result are then collected.

Orchids produce their seeds in pods. Not all seed pods will contain seeds as one or the other parent may be sterile (some plants can produce pods without seeds even if no fertilisation has occurred). Orchids also possess very small seeds that do not contain any nutrient tissue to nourish the embryo. In their natural environment many orchids form mutually beneficial relationships with fungi, which are required for the orchids' seeds to germinate. The fungus provides nutrition for the embryos; in the absence of the fungus, special measures must be taken to germinate the seeds. To grow orchids from seed commercially, the seeds must be grown in agar* that contains nutrients and growth hormones.

It takes months for the first leaves to develop, and, even then, they will only be visible with a magnifying glass. Roots appear even later. It will be at least three, and possibly as many as eight years before they flower.

Plants resulting from sexual reproduction may display very diverse traits. Among these siblings one or several may be significantly more appealing or different than the others in terms of flower stalk length, flower colour and flower shape. Seed-raised plants can be used for conservation and breeding for the selection of superior features.

*agar is a gel-like substance made from seaweed which can be mixed with various growth promoting substances. Plants can therefore grow in agar in the same manner as in soil.

[Adapted: <https://www.orchidsusa.com>]
[Adapted: <https://www.pinoybisnes.com>]
[Adapted: <https://www.tohgarden.com>]
[Adapted: Paek, K. Y., Hahn, E. J. & Park, S. Y. Micropropagation of *Phalaenopsis* orchids viaprotocorms and protocorm-like bodies]

Asexual reproduction

Asexual reproduction is important in obtaining plants that look identical to their parents. The most common method of asexual reproduction is called tissue culture.

Tissue culture

This procedure involves taking small samples of tissue from the orchid, called 'explants', and placing them onto an agar solution containing various nutrients and hormones. Various hormones are used in the process – cytokinin hormones stimulate plant growth and development through cell division and also stimulates flowering. Auxins are responsible for the growth of roots.

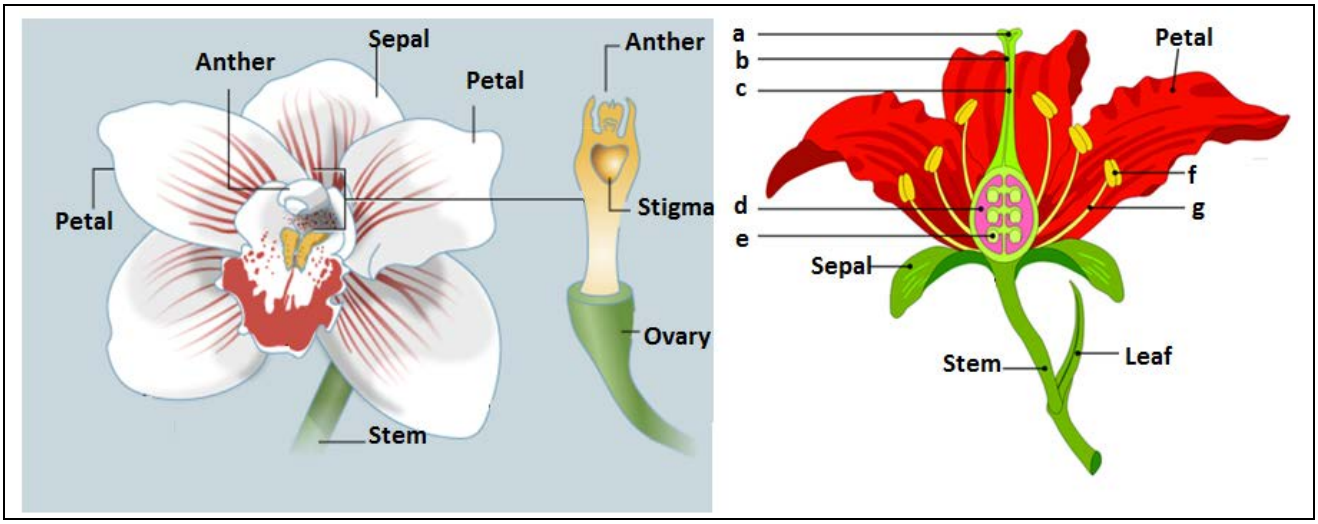
When the explant (a small mass of cells), has grown some more, it is again cut into small sections and again placed into the agar solution with different types and quantities of hormones. When these bunches of cells start differentiating into roots, stems and leaves, the small plants can be planted individually and allowed to grow. The whole process must be conducted in completely sterile conditions to avoid infection by fungi or bacteria.

The most commonly used tissue explants are the embryonic stem cells from the ends of the plants like the stem tip and root tip. These tissues have high rates of cell division and produce large quantities of their own growth-regulating hormones.
There are various applications of tissue culture besides producing large quantities of plants:

- To conserve rare or endangered plant species.
- To screen cells for advantageous characters, e.g. herbicide resistance/tolerance.
- Large-scale growth of plant cells for the production of valuable compounds.
- For chromosome doubling and inducing polyploidy. This is usually achieved by application of substances such as colchicine when the explant is placed into the agar. Colchicine inhibits the production of spindle fibres during mitosis.
- The production of identical sterile hybrid species.

[Adapted: <https://www.igdir.edu.tr>]
[Adapted: Chugh, S., Guha, S. & Usha R. 2009. Micropropagation of orchids: A review on the potential of different explants. *Scientia Horticulturae* 122: 507–522]

Figure 2 – Diagram of an orchid flower **Diagram of a lily flower**

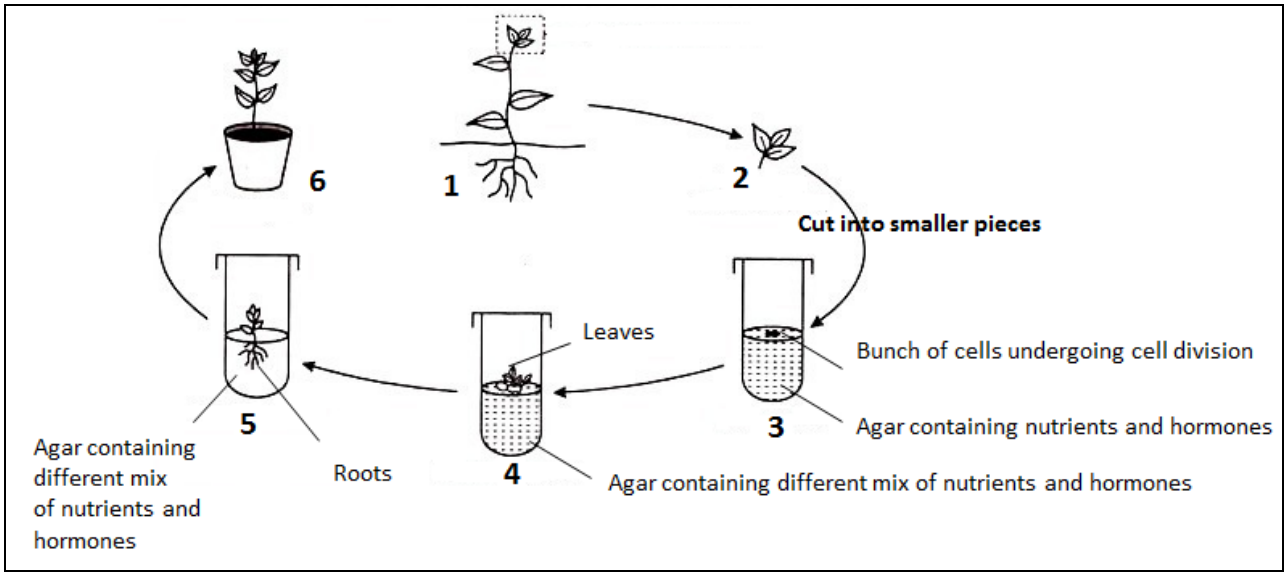


[Adapted: <https://www.orchids24.de>] [Adapted: <https://dyna-gro.com>]

"(Hybridisation) is like a box of chocolate. You never know (for sure) what you're gonna get!" – Forrest Gump.

[Adapted: <https://www.shmoop.com/quotes>]

Figure 3 – Cloning of orchids



[<https://lh3.googleusercontent.com/>]

QUESTION 2

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

The Progression of Contraception

Male barrier methods

Condoms

The male condom is a sheath placed over the erect penis before penetration, preventing pregnancy by blocking the passage of sperm. The earliest known use of condoms is depicted in 3 500 year old Egyptian paintings. The oldest existing condoms were found in the foundations of Dudley Castle in England. They were made of animal intestines and date to 1640.

Figure 4 – Goat intestine condoms **Modern Durex© brand condom**

[<https://i.pinimg.com>] [https://www.dailydot.com>]

Natural rubber was used from the 1800s to make condoms. One of the drawbacks in using natural rubber to make condoms is that is it susceptible to breakdown with the use of oil-based lubricants. In 1997 the first polyurethane condom was launched in the UK. This substance is stronger, less sensitive to heat and humidity, and not damaged by oil-based lubricants.

Condoms can work 98% of the time to prevent conception. They also protect users from sexually transmitted diseases like herpes and chlamydia.

[Adapted: <https://www.medicalnewstoday.com>]

Female Barrier Methods

Throughout history women have used various substances to block the way to the uterus. These included seedpods, grass, crushed roots, seaweed, moss, bamboo and empty halves of pomegranates. In the first half of the sixth century, the Greek physician Aetius suggested that women smear their cervices with tree resin combined with lead or wine. He also suggested that their partners coat their penises with pomegranate or vinegar! None of these methods is very effective and is *definitely* not safe!

Figure 5 – Different types of diaphragm

[https://encrypted-tbn0.gstatic.com>]

The Italian adventurer, Giovanni Giacomo Casanova, takes credit for inventing a primitive version of the ***diaphragm/ cervical cap*** in the 1700s. He placed the partly squeezed halves of lemons over his lovers' cervices. Similar devices had been used for centuries around the world – oiled paper discs, sponges, tissue paper, wax, rubber and wool have all been used to cover the cervix in an attempt to prevent unintended pregnancy. Again, these methods are not very effective and could be very dangerous, causing injury and infections.

The *diaphragm* played a special role in American birth control activist and nurse, Margaret Sanger's effort to rescue women from America's conservative, backward and restrictive contraceptive laws. During a trip to Holland in 1915, she learned about the use of snugly fitting diaphragms that were developed in Germany during the 1880s. In 1916, she was arrested and sent to jail for telling women about them. Her month in jail only strengthened her resolve to teach women how to use diaphragms —she even taught diaphragm use to the women she was with in jail.

[Adapted: Bullough, V. L. & Bullough, B. 1987. *Women and Prostitution – A Social History*. Buffalo, NY: Prometheus Press]
[Adapted: Chesler, E. 1992. *Woman of Valour: Margaret Sanger and the Birth Control Movement in America*. New York: Simon and Schuster, London]
[Adapted: Himes, Norman E. 1963. *Medical History of Contraception*. New York: Gamut Press, Inc.]
[Adapted: Suitters, B. 1967. *The History of Contraceptives*. London, UK: The Fanfare Press, Ltd.]
[Adapted: <https://www.mayoclinic.org>]
[Adapted: Tone, A. 2001. *Devices and Desires – A History of Contraceptives in America*. New York]

Contraceptive Pill

Oral contraceptives date back more than 2 000 years. Early preparations varied from eating willow shoots and bees to consuming the scrapings of male deer horns – all of which are completely ineffectual. However, work by Gregory Pincus, Carl Djerassi and John Rock resulted in the development of modern oral contraceptives in the 1950s. **Birth control pills** contain synthetic forms of oestrogen and/ or progesterone.

The pill is widely regarded as the turning point in humankind's struggle to control fertility. The two most common forms of contraception until 1960, the condom and *coitus interruptus* (withdrawal of penis before ejaculation), relied entirely on the man, but the pill put women in charge of preventing pregnancy and gave them effective control of their own fertility. As use of the pill increased, unintended pregnancies decreased and infant mortality rates dropped. Throughout history, a woman's fertile years were often dominated by pregnancy and breastfeeding; now, those 35 years were interrupted by only one or two pregnancies on average. This has had a profound impact on millions of women.

[Adapted: Croxatto, H. B., et al. 2003. Mechanisms of action of emergency contraception. *Steroids*: 68: 1095–8]
[Adapted: Fine, P. T., et al. 2010. Ulipristal Acetate taken 48-120 Hours after Intercourse for emergency contraception. *Obstetrics and Gynaecology*: 115 (2): 1–7]
[Adapted: Grimes, D. A, ed. 1992. Highlights from an international symposium on IUDs. *The Contraception Report* 3(3): 4]

Sterilisation

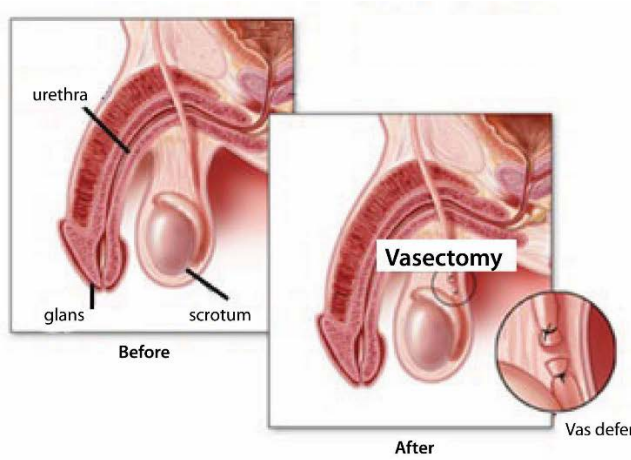
Vasectomy

Vasectomy is also known as "male sterilisation". It is a minor surgery to block sperm from reaching the semen. After a vasectomy the testes still make sperm, but they are destroyed by the immune system after a while. A vasectomy prevents pregnancy better than any other method of birth control, except abstinence. Only 1 to 2 women out of 1 000 will get pregnant in the year after their partners have had a vasectomy.

Female sterilisation

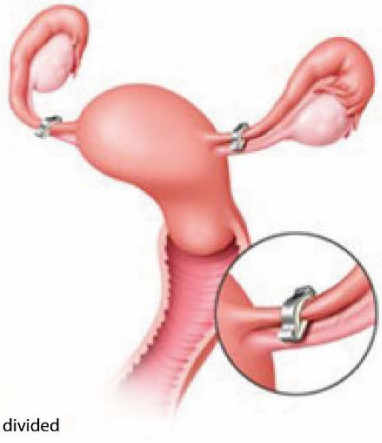
Tubal ligation is a type of permanent birth control. During tubal ligation, the fallopian tubes are cut, tied or blocked to permanently prevent pregnancy. Tubal ligation prevents an ovum from traveling from the ovaries through the Fallopian tubes and blocks sperm from traveling up the Fallopian tubes to the ovum. Various rings and clips are now used to block the Fallopian tubes. The Fallopian tubes are circular in cross section, lined with muscle tissue and ciliated epithelial tissue. The cilia help to propel the egg towards the uterus.

Figure 6 – Vasectomy



[Adapted: <https://www.urologyhealth.org>]

Tubal ligation



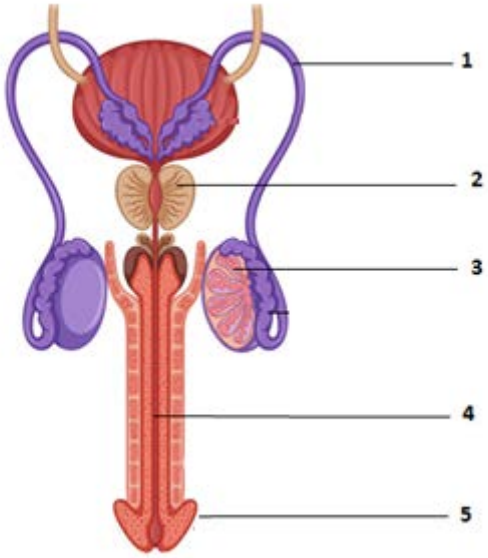
[Adapted: <https://www.mayoclinic.org>]

[Adapted: <https://www.fpa.org.uk>; <https://www.webmd.com>; <https://www.urologyhealth.org>]

We have come a long way in a very short time, but while the 20th century could justifiably be called the century of contraception, perhaps the irony is that in the 50 years since the pill became available, world population has more than doubled. As humanity breeds itself toward eight billion and beyond, the story of contraception is far from over.

[Adapted: <https://www.nationalgeographic.com>]

Figure 7 – Diagram of the Male Reproductive System

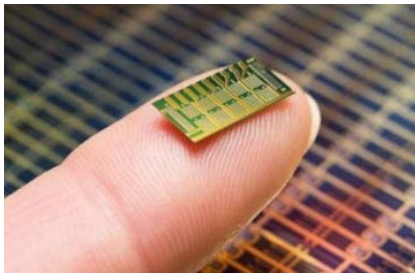


[Adapted: <https://cdn5.vectorstock.com>]

These amazing new contraceptives could be the future of birth control

Today, we are on the brink of microchip implants that could release contraceptive hormones over many years and be switched on and off as needed via remote control. Apps are being developed to monitor key fertility indicators in a woman's body, and the long-promised male pill may yet make an appearance – though perhaps as a spray or cream that uses a protein to slow down sperm production.

Figure 8 – This remote-controlled implant could provide women with contraception for up to 16 years



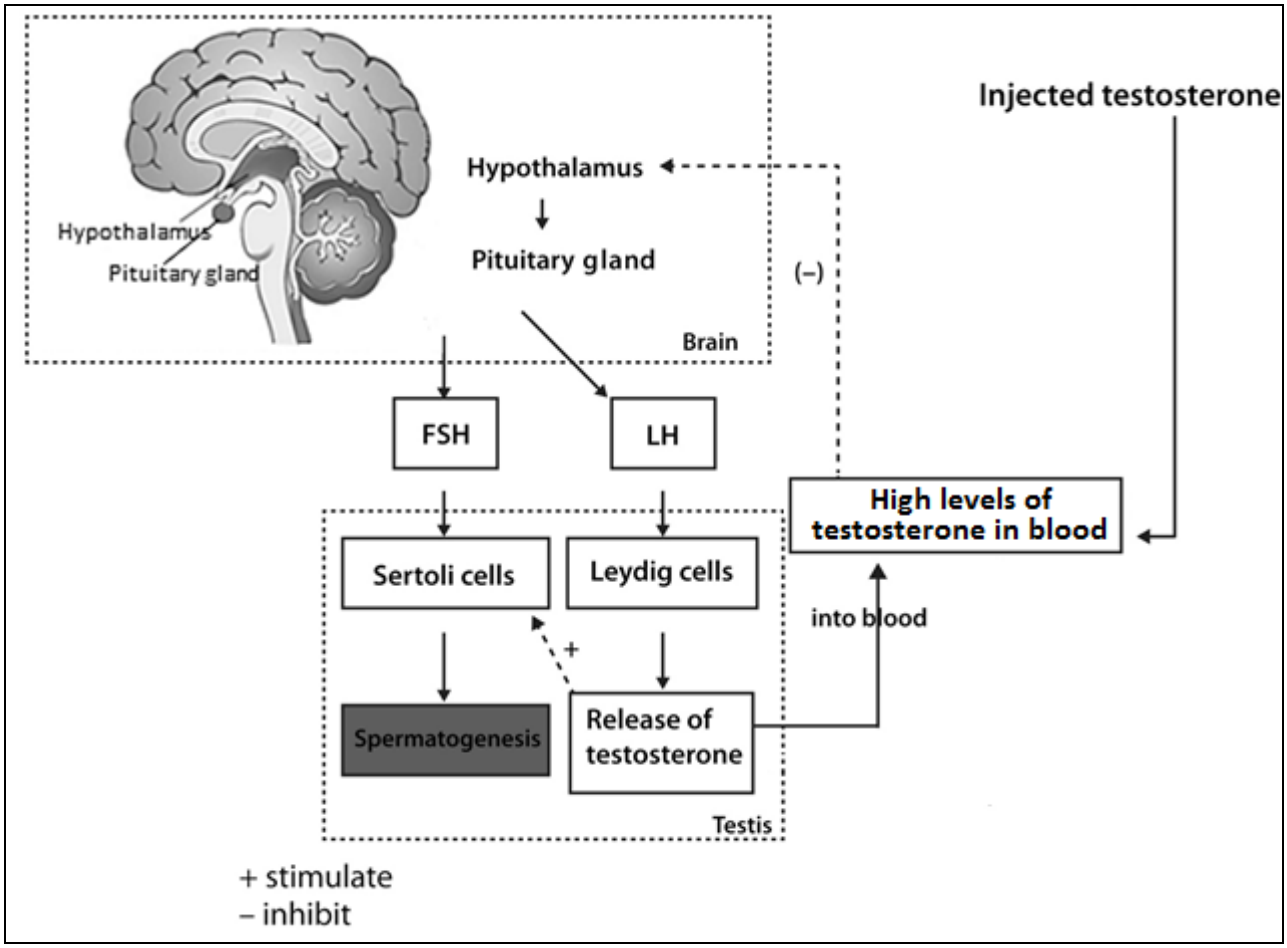
[MicroCHIPS Biotech]

One of the most promising concepts for the future of male birth control is being developed right now in India. It's known as RISUG, which stands for Reversible Inhibition of Sperm Under Guidance. A doctor injects the vas deferens with a gel that makes the sperm unable to travel. The procedure lasts for years and can be reversed at any point with another injection. Trials in India have showed that the procedure was 100 percent effective in preventing pregnancy.

The World Health Organisation (WHO) funded two studies which provided proof that a male hormonal contraceptive along the lines of the female pill could work. These studies relied on giving 400 healthy, fertile men high doses of testosterone. Three consecutive semen samples were then taken from each man. No sperm was found in 157 of these men.

[Adapted: Contraceptive efficacy of testosterone-induced azoospermia in normal men. 1990. *Medical Science* 336(8721): 955–959]

Figure 9 – Flow diagram showing hormonal control of sperm production



[Adapted: Amir Shahreza Patel, A. S., Leong, J. Y., Ramos, L. & Ramasamy, R. 2019. Testosterone Is a contraceptive and should not be used in men who desire fertility *World Journal of Mens Health* 37(1): 45–54]

[Adapted: O'Rand, M.G., Widgren, E.E., Sivashanmugam, P. 2004. Reversible immunocontraception in male monkeys immunised with eppin. *Science* 306:1189–1190]

[Adapted: <https://www.plannedparenthood.org>]

[Adapted: <https://www.vox.com>]

[Adapted: <https://pmgbiology.files.wordpress.com>]

SECTION B

QUESTION 3

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

SOURCE A Doping in sports

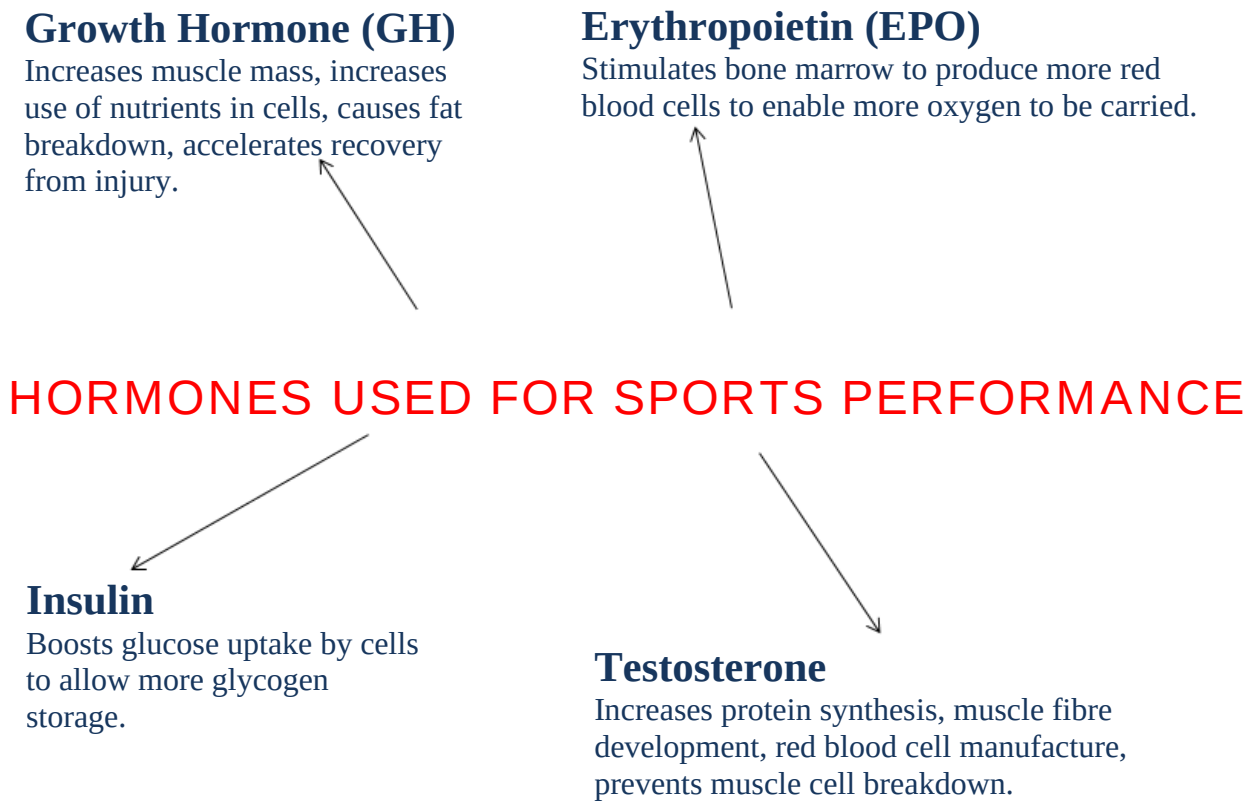
'*Doping*' refers to an athlete's use of prohibited drugs or methods to improve training and sporting results.

[<https://www.unesco.org>]

The use of performance enhancing drugs in modern sporting events is on record as early as the games of the third Olympic Games, when Thomas Hicks won the marathon after receiving an injection of strychnine in the middle of the race. Even though strychnine is a deadly poison, small doses can act as a muscle stimulant. However, it is extremely dangerous.

[Adapted: Hermann, A., Henneberg, M. 2014. Long term effects of doping in sporting records: 1886–2012. *Journal of Human Sport and Exercise* 9 (3): 727]

Athletes have used a variety of performance enhancing chemicals ever since competitive sport began:



[Adapted: Baumann, G. P. 2012. Growth Hormone Doping in Sports: A critical review of use and detection strategies. *Endocrine Reviews* 33(2):155–186]
[Adapted: De la Torre, X., Brito, M. & Botré, D. *Thyroid hormones in sport: use or abuse?* Federazione Medico Sportiva Italiana, Italy]
[Adapted: Saudan, C., Baume, N., Robinson, N., Avois, L., Mangin, P. & Saugy, M. 2006. Testosterone and doping control. *British Journal of Sports Medicine* 40(1): 21–24]
[Adapted: <https://www.medicinenet.com>]
[Adapted: <https://www.theguardian.com>]

SOURCE B RULES OF SPORTSMANSHIP

[Adapted: <https://www.olympic.org>]

SOURCE C RIGHT OR WRONG?

Those who oppose the use of steroids and other performance-enhancing drugs say that the athletes who use them are breaking the rules and getting an unfair advantage over others. The athletes are endangering not only their own health, but also indirectly encouraging youngsters to do the same. Others maintain that it is hypocritical for society to encourage consumers to seek drugs to treat all sorts of illnesses and conditions, but to ban drug use for sports.

When athletes train for competitions, they choose what type of training to use, what diet to follow and what equipment and supplements to choose. There is a huge range of different supplements and sporting equipment to choose from. Hormones are simply another one of these. Far from being against the spirit of sport, biological manipulation embodies the human spirit – the capacity to improve athletes on the basis of reason and judgment. The result will be that the winner is not the person who was born with the best genetic potential to be strongest. Sport would be less of a genetic lottery.

Classical musicians commonly use beta blocker drugs to control their stage fright. These drugs lower heart rate and blood pressure, reducing the physical effects of stress, and it has been shown that the quality of a musical performance is improved if the musician takes these drugs. No one complains about the use of these drugs. We do not think less of the violinist or pianist who uses them. If the audience judges the performance to be improved with drugs, then the drugs are enabling the musician to express him or herself more effectively.

[Adapted: Matei, R. & Ginsborg, J. 2017. Music performance anxiety in classical musicians – what we know about what works. *British Journal of Psychology International* 14(2): 33–35]

[Adapted: Savulescu, J. & Foddy, B. 2010. *Le Tour and Failure of Zero Tolerance: Time to Relax Doping Controls*. In Savulescu, J., Kahane, G. & Ter Meulen, R. Enhancing Human Capacities. (eds), Blackwell]

The difference between gold medallists and making second place may be measured in fractions of seconds or millimetres. A tiny advantage can make all the difference. What if that advantage comes from using a performance-enhancing drug? For athletes who want to compete clean, the threat that they may be beaten by a competitor who is not faster, stronger, or more dedicated, but who takes a drug to gain the edge, is very personal. Performance-enhancing drugs affect the individual athlete psychologically – when an athlete wins by using a performance-enhancing drug, what does that mean for the athlete's own understanding of what happened? Am I the world's best? Or was my supposed victory affected by the drug's effects? We expect the winning athlete to combine extraordinary natural talents with effort, training, and technique. Natural talents should be respected for what they are: the occasionally awesome luck of the biological draw. Courage, strength, competitiveness, and other virtues rightfully demand our moral admiration. The other factors – equipment, coaching, and nutrition – contribute to an athlete's success but don't induce the same appreciation.

Allowing drugs in the sports world ultimately takes away from the true purpose of playing and watching sports because we love them. Doping centres everything around just the opposite: winning and losing. It diminishes the values that should drive an athlete, including character, integrity, sportsmanship, skill and talent.

[Adapted: Haisma, H. J. & de Hon, O. 2006. Gene Doping. *Int. J. Sports Med.* 27: 257–266]
[Adapted: Murray, T.H. 2004. *Drugs, sports, and ethics.* BMJ Publishing Group]

SOURCE D A lesson from History?

Sporting authorities have adopted a policy of prohibition for performance-enhancing drug use in sport, but history dictates that this is a strategy doomed to fail. This was seen to good effect in America when in January 1920 the sale and use of alcohol was prohibited (banned) in order to prevent alcoholism and the associated crimes. This was the period known as 'Prohibition'. Prohibition was difficult to enforce. Far from its proposed effect, alcohol consumption increased as people found ways to brew their own liquor, and sell it in illegal nightclubs. Organised crime therefore thrived, and corruption among government officials soared as they were paid to 'look the other way'. The quality of the alcohol was often very poor, contaminated with toxic levels of methanol and other waste products. As the quality of the alcohol was unregulated, the incidence of death from poisonous alcohol rose fourfold in five years. In early 1933, Congress adopted a resolution proposing an end to 'Prohibition'.

Party serving illegal liquor during Prohibition
[<https://images.squarespace-cdn.com>]

[Adapted: Dawson, R. T. 2009. Hormones and Sport. Drugs in Sport – The role of the physician. Drugs In Sport Clinic and User's Support (DISCUS)]
[<Adapted: https://www.history.com>]

SOURCE E NATURAL EPO LEVELS, GENETICS

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.

There is no difference between elevating your blood count by altitude training, by using a hypoxic air machine, or by taking EPO. But the last method is illegal. Some can afford hypoxic air machines and altitude training while others cannot.

High Altitude training Camp – Flagstaff Arizona

Location: Flagstaff, AZ
Elevation: 2134 m above sea level
Duration: 7 days
What you get: 10 guided trail runs, 1 long run, 2 track workouts, airport transportation, lunch daily, one-on-one coaching, 5 Classroom sessions

Costs:

Training Camp Registration Cost: R 12 040
Cost of Flights (Toronto to Flagstaff Round trip): ~R13 097
Accommodation (Watson Lake Inn): R28 016
Food/Extras: R10 000
Total Cost: ~R 62 060

[Adapted: <https://altitudeathletictraining.com>]

R 350

[<https://www.peptides.co.za>]

[Adapted: Browne, A., LaChance, V. & Pipe, A. 1999. The ethics of blood testing as an element of doping control in sport. *Med. Sci Sports Exercise* 31:497–*501*]

[Adapted: House of Commons, Select Committee on Culture, Media and Sport. 2004. Seventh Report of Session 2003–2004, UK Parliament, HC 499]

Olympic swimmer Ian Thorpe has enormous feet which give him an advantage that no other swimmer can get, no matter how much they exercise. Some gymnasts are more flexible, and some basketball players are seven feet tall. By allowing everyone to take performance enhancing drugs, we level the playing field. We remove the effects of genetic inequality. Far from being unfair, allowing performance enhancement promotes equality.

The Finnish skier Eero Mäntyranta won three gold medals in 1964. Subsequently it was found he had a genetic mutation – primary familial and congenital polycythaemia (PFCP) causing an increase in red blood cell number and haemoglobin due to a mutation in the EPO receptor gene. This condition results in an increase of up to 50% in the oxygen carrying capacity of the blood, a large advantage when participating in endurance events.

Sport discriminates against the genetically unfit. Sport is the province of the genetic elite.

Ian Thorpe's feet – size 17
[<https://www.abc.net>]

Eero Mäntyranta
[<https://upload.wikimedia.org>]

[Adapted: Browne, A., LaChance, V. & Pipe, A. 1999. The ethics of blood testing as an element of doping control in sport. *Med. Sci. Sports Exercise* 31*:*497–*501*]

[Adapted: House of Commons, Select Committee on Culture, Media and Sport. 2004. Seventh Report of Session 2003–2004, UK Parliament, HC 499]

[Adapted: Shahmoradi, S., Ahmadalipour, A. & Salehi, M. 2014. Evaluation of ACE gene I/D polymorphism in Iranian elite athletes. *Adv. Biomed. Res.*2014(3): 207]

SOURCE F HEALTH EFFECTS

Raising the number of red blood cells can cause health problems such as risk of stroke or heart attack. Because the effect of drugs is profoundly different between people, sports events would be determined in large part by whose body responds best to chemicals. Training is active, you have to do the work to earn the benefit. Doping is not, so it fundamentally changes the outcome of the sport without changing the input. The most ambitious person would be the most reckless person – the one to take the most drugs possible without killing or harming themselves. If most athletes are deciding to use steroids, then many of the players who do not wish to suffer from the long-term effects will feel pressurised into using illegal substances themselves.

Effects of testosterone on the body

- Severe acne
- Increased risk of tendinitis and tendon rupture
- Liver abnormalities and tumours
- Increased cholesterol
- High blood pressure
- Heart and blood circulation problems

[Adapted: <https://www.mayoclinic.org>]

SOURCE G TECHNOLOGY

Athletes already radically change their bodies through advanced, technologically driven training regimes. Tour de France cyclists receive intravenous artificial nutrition and hydration overnight because their bodies cannot take on enough food and fluid naturally. Ben Johnson, stripped of his 100 metres Olympic gold at the 1988 Games, said that the human body was not designed to run the speeds it is called upon to run now, and steroids were necessary to recover from the gruelling training and injuries.

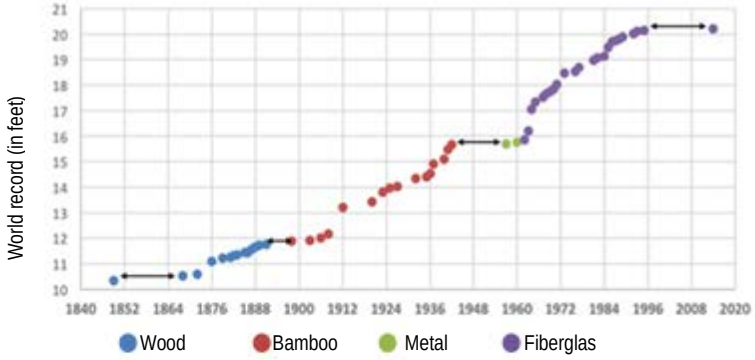
[Adapted: Savulescu, J. & Foddy, B. 2010. *Le Tour and Failure of Zero Tolerance: Time to Relax Doping Controls*. In Savulescu, J., Kahane, G & Ter Meulen, R. Enhancing Human Capacities. (eds), Blackwell]
[Adapted: <https://sportsscientists.com>]
[Adapted: <https://www.npr.org>]

The United States Bobsled team has teamed up with German Car Manufacturer BMW to help design their Bobsleds. BMW has completely redesigned it and has built the thing entirely out of carbon fibre. It is a certainty that the American Bobsleds will be quicker and more aerodynamic.

Bobsled [<https://mabuhaynews.ca>]

Reduced skin friction drag.

23 out of 25 world records in Olypmics 2008 were made by swimmers wearing his swimsuit.



Graph showing improvement pole vaulting records between 1840 and 2012
[Adapted: <https://business.uoregon.edu>]

Eliud Kipchoge, who holds the world marathon record, donned a Vaporfly prototype in October when he ran the first sub-2-hour marathon ever. Both independent and Nike-sponsored studies have confirmed that the shoes increase athletes' energetic efficiency by 4% or more, which yields significant dividends in marathon-length distances.

[<https://www.runnerinn.com>]

[Adapted: <https://jurysoutblog.wordpress.com>]
[Adapted: <https://www.washingtonpost.com>]

SOURCE H FAMOUS ATHLETES CAUGHT DOPING

Diego Maradona – footballer – ephedrine

Linford Christie – sprinter – Nandrolone

Marion Jones – sprinter/ long jump – THG

Ben Johnson– sprinter – testosterone

Lance Armstrong – cyclist – EPO, testosterone, GH, cortisone

Mary Decker – middle distance athlete – testosterone

Carl Lewis – sprinter/long jump – pseudoephedrine

Tyson Gay – sprinter– testosterone

[<https://images.daznservices.com>]
[<https://www.telegraph.co.uk>]
[<https://www.i.pinimg.com>]
[<https://www.upload.wikimedia.org>]
[<https://www.britannica.com>]