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WOODHILL COLLEGE

LIFE SCIENCES 2024

GRADE 12

Preliminary Exam

Paper 2

Marks: 100

Time: 2 Hours

Assessor: Ms. A. Ponelis, Mrs. L. van der Hoven

Moderator: External moderators



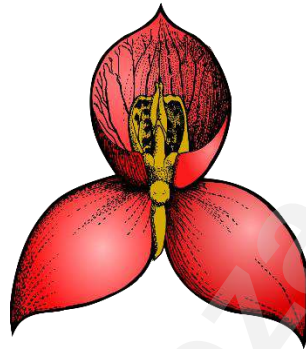
SOURCE BOOKLET

QUESTION 1

SOURCE A

Cape Fynbos vegetation grows on sandy, nutrient poor soils. The plants are specially adapted to survive under these conditions, and to gain the most benefit from the sparse soil. Many of the plants occurring in this biodiversity hotspot are unpalatable, yet multiple animals survive here, feeding on the nectar in the variety of flowers and the seeds.

One example of an herbaceous flowering plant that is found in the Fynbos biome is the Red Disa. (*Disa uniflora*)



These flowers occur naturally close to streams or waterfalls in the south and south-west of South Africa. The Red Disa is strictly protected and is the symbol of the Western Cape. The flowers are mostly red or pinkish, but occasionally yellow flowers have also been seen. The Mountain Pride butterfly is the only known pollinator of this flowers.



Mountain Pride butterfly (Aeropetes tulbaghia)

It is the largest butterfly in South Africa and has a dark brown body and wings, with bright orange lines across the wings. White eye-marks are on the hind wings, surrounded by purple and black circles. They occur in mountainous habitat and are the only known species which distributes the pollen of the Red Disa.

[Adapted from: <<https://safoodwebs.weebly.com/fynbos.html>>]

SOURCE B

Orchid sexually exploits male beetles – a world-first from Africa

Adapted from: Dr Callan Cohen et al published on the 27th of May 2021



This African orchid, “*Disa forficaria*”, mimics a female beetle so convincingly that the male beetle mates with the flower, thus pollinating it.

Dr Callan Cohen, a research associate of the University of Cape Town’s (UCT) FitzPatrick Institute of African Ornithology, has discovered a world pollination first: an orchid that sexually exploits longhorn beetles. The near-extinct *Disa forficaria*, known from a single remaining plant in the mountains near Cape Town, mimics a female beetle so convincingly that the male beetle mates with the flower.

Dr Cohen and a team of local and international researchers discovered an entirely new chemical system involved in this deception, and they are pioneering the process of using pollination to survey for the presence of critically endangered plants. These discoveries stem from Cohen’s search for rare African orchids in the mountain ranges near Cape Town. *Disa forficaria* – a relative of the iconic Red Disa – was last seen in 1966 and only 11 of these plants have been found in the last 200 years, making it one of the rarest plants in the world.

It produces one flower at a time; and when Cohen first saw it, the flower had withered. But he persisted, visiting a further four times until another flower bud slowly ripened. On his fourth visit, Cohen was excited to see that a second flower had opened, as it has one of the most mysterious shapes of any orchid.

Deceived beetles

“Incredibly, while I was observing, a beetle flew to the plant and clearly mated with it,” he recalled.

With his interest in pollination biology, Cohen immediately realised the significance of the observation, and captured it with his camera.

Beetles are the oldest-known pollinators of plants, and the most diverse group of plant pollinators, Cohen had discovered what was to become the first clear case of a plant sexually deceiving a beetle. The other systems of deception have been studied extensively; but how, wondered Cohen, did this new system work with beetles? And could it be described from only a single living plant?

Proving sexual deception

The next step was to prove that what Cohen had witnessed was indeed sexual deception. He assembled a joint South African and international team to investigate the phenomenon, including UCT alumnus and world-famous pollination researcher Professor Steven Johnson; the University of KwaZulu-Natal's Dr Adam Shuttleworth; UCT's Centre for Statistics in Ecology, Environment and Conservation associate Dr Jonathan Colville; and orchid experts William Liltved and Benny Bytebier.

Using detailed photography, Cohen noticed that the beetle had a small, penis-like organ which it inserted into the modified lip of the flower. But would they find sperm on the plant? Cohen took several macro photographs of the flower just before the moment he predicted the beetle would get to the flower. The beetle duly visited the flower, and then flew off – leaving something behind. The substance was tested, and conclusively showed sperm.



Near-extinct "*Disa forficaria*" mimics the appearance and chemistry of a female beetle.

A new chemical system

Following this discovery, the researchers posed another question: What chemical was attracting the beetle to the flower?

"We wondered if there was a whole new chemical system that hadn't yet been described," said Professor Johnson.

To answer this, the team took a sample from the flower and caught a beetle to test in the laboratory.

They began by vaporising a piece of the flower in a gas tube; then they looked at the electrical impulse of the beetle's antennal response, before correlating the molecular weight of the emitted chemical. From this, they found that the active chemical in the flower was what had attracted the beetle.

The team sent the plant extract to a top chemist in Germany, the Max Planck Institute's Dr Ales Svatos, who discovered the chemical involved and whose colleague, Dr Jerri Weissflog, synthesised possible forms of its molecular structure. The chemical was a newly discovered macrolide, which the team named "disalactone".

Cohen's research team tested the synthesised molecules in the field, to find out which forms of the plant's chemical the beetle would be attracted to.

"Fascinatingly, the beetles all came to a particular form of the synthesised component, believed to be a mimic of the female beetle chemical signals produced by the orchid," said Cohen.

A conservation world-first

However, on returning to the plant site the team discovered that the plant had disappeared; only a dug-out hole remained. They didn't know whether this was due to the actions of an overzealous orchid collector, or the work of a porcupine. Fortunately, another discovery awaited them.

During their experiment with the synthesised molecules, they discovered that some of the beetles were carrying pollen (confirmed by genetic barcoding) from at least two other individuals of the *Disa*, proving the plant is not extinct.

The team realised that they could now survey for the flowers by using the synthesised chemical to attract beetles that might carry evidence of the real orchids.

"This resulted in narrowing down the area where the rare plants exist and allows for a concentrated search for the orchid.

"Using pollinators to see if an endangered plant is present in the area is a world-first," said Cohen.

"This discovery can help save the critically rare orchid, on the edge of extinction, with a novel chemical survey technique."

SOURCE C

THE MILLENNIUM SEED BANK PARTNERSHIP

Posted on February 23, 2017 in *The Newsletter of the Hermanus Botanical Society*

The Millennium Seed Bank Partnership is the largest international plant conservation project in the world. Its aim is to safeguard as many as possible of the planet's plant species by saving their seeds for the future. The current goal is to bank seeds from 25% (approximately 75,000) of the world's plant species by 2020.

The Seed Bank is housed by Kew Gardens in the UK in a highly-specialised facility, at both very low temperature (- 20°C) and humidity. Seed can potentially remain viable for hundreds of years under these conditions.

Seed Bank Partners so far are from more than 50 countries, including South Africa's SANBI (South African National Biodiversity Institute) which has been involved almost from the start. SANBI has asked Hermanus Botanical Society to help with this project by collecting seed from plants in Fernkloof that has not yet been banked. Current emphasis is on plants that appear infrequently only after a fire – while there is still the opportunity – but collections are also being made more widely in the reserve. The Red *Disa* being one of the sought after species.

QUESTION 2

SOURCE A

"We Used to Call Them Hermaphrodites" - Summary

Authors: Eric Vilain, John C Achermann, Erica A Eugster, Vincent R Harley, Yves Morel, Jean D Wilson & Olaf Hiort

Published: February 2007

Journal: Genetics in Medicine, volume 9, pages 65–66 (2007)

Sex is complex and involves various factors like chromosomes, genes, gonads, hormones, and internal reproductive structures. Historically, sex was classified into five types, based on gonads.

Since the 1940s, it became clear that this model was too simplistic. Sex development involves two stages: sex determination and sex differentiation. The discovery of the SRY gene showed that mutations could cause variations in sex development.

The old terms "hermaphrodite" and "pseudohermaphrodite" are now seen as vague and potentially harmful. In 2005, experts proposed replacing them with "disorders of sex development" (DSD), meaning conditions where sex development is atypical. This change aims to provide more precise, respectful, and clear terminology, benefiting both patients and medical professionals.

[Source:< [We used to call them hermaphrodites | Genetics in Medicine \(nature.com\)](#)>]

Article simplified and summarised using: <ChatGPT>

SOURCE B

What is androgen insensitivity syndrome?

Androgen insensitivity syndrome (AIS) occurs when someone is genetically male but is insensitive to androgens (male sex hormones). This means the person has male sex chromosomes (one X and one Y chromosome) but may have female genitals.

It affects male foetuses as they develop in the uterus, as well as sexual development during puberty. AIS prevents male genitals from developing as they should.

There are three types of AIS:

Complete androgen insensitivity syndrome (CAIS): A person's external genital appears female. But they don't have female sex organs (no ovaries, fallopian tubes or uterus). People with CAIS are often raised as girls.

Partial androgen insensitivity syndrome (PAIS): A person's external genitals may appear partially (not fully) developed male or female or may not be clearly one or the other. People with PAIS are often raised as boys, but not always.

Mild androgen insensitivity syndrome (MAIS): A person's genitals appear male, but they're usually infertile. Some experts consider MAIS a type of PAIS.

Who gets androgen insensitivity syndrome?

Males who inherit an abnormal gene, called the androgen receptor (AR) gene, from their mothers have a 1 in 4 chance of developing AIS. Females can also inherit and carry the gene, but they won't develop AIS.

[Article adapted from: <[Androgen Insensitivity Syndrome: Complete & Partial \(clevelandclinic.org\)](https://clevelandclinic.org)>]

SOURCE C

Hermaphroditism

Hermaphroditism, the condition of having both male and female reproductive organs. Hermaphroditic plants—most flowering plants, or angiosperms—are called monoecious, or bisexual.

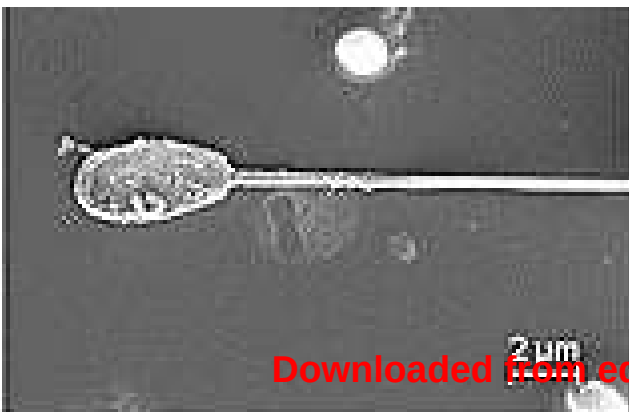
In humans, conditions that involve discrepancies between external genitalia and internal reproductive organs are described by the term *intersex*. Intersex conditions are sometimes also referred to as disorders of sexual development (DSDs). Such conditions are extremely rare in humans.

Individuals with a 46,XX chromosome complement usually have ambiguous external genitalia with a sizable phallus and are therefore often reared as males. However, they develop breasts during puberty and menstruate and in only rare cases actually produce sperm.

Historically, if diagnosed at birth, the choice of sex was made (typically by parents) based on the condition of the external genitalia (i.e., which sex organs predominate), after which so-called intersex surgery was performed to remove the gonads of the opposite sex. The remaining genitalia were then reconstructed to resemble those of the chosen sex. The reconstruction of female genitalia was more readily performed than the reconstruction of male genitalia, so ambiguous individuals often were made to be female.

In older individuals the accepted gender may be reinforced by the appropriate surgical procedures and by hormonal therapy.

[Article adapted from: <[Bisexuality | biology | Britannica](https://www.britannica.com)>]

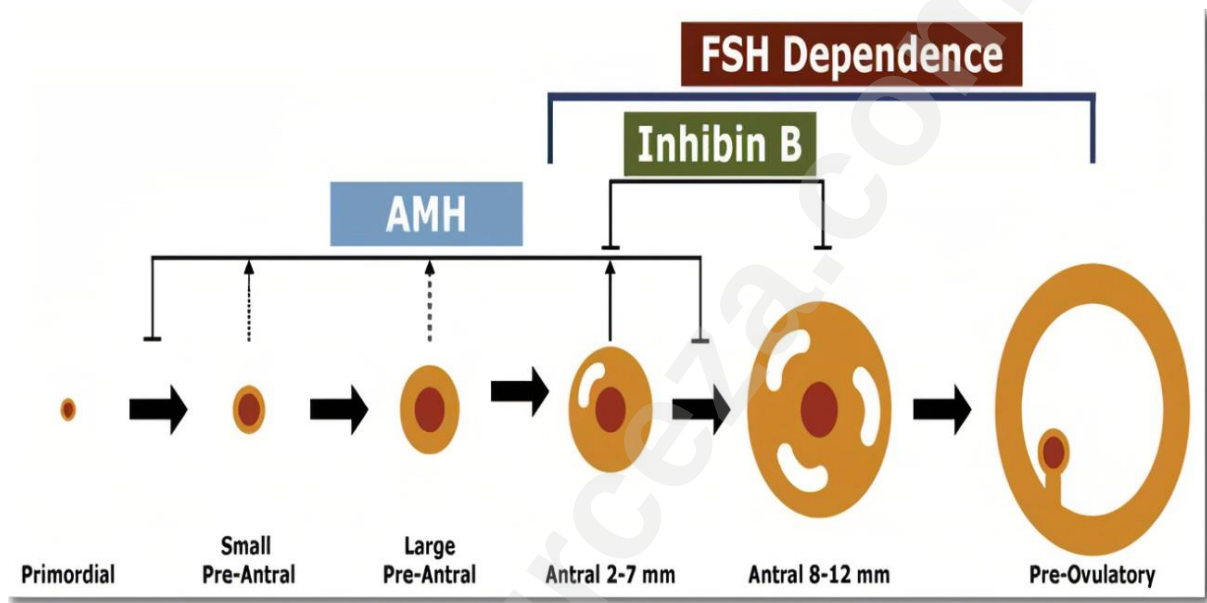


[Image: <<https://www.researchgate.net>>]

SOURCE D

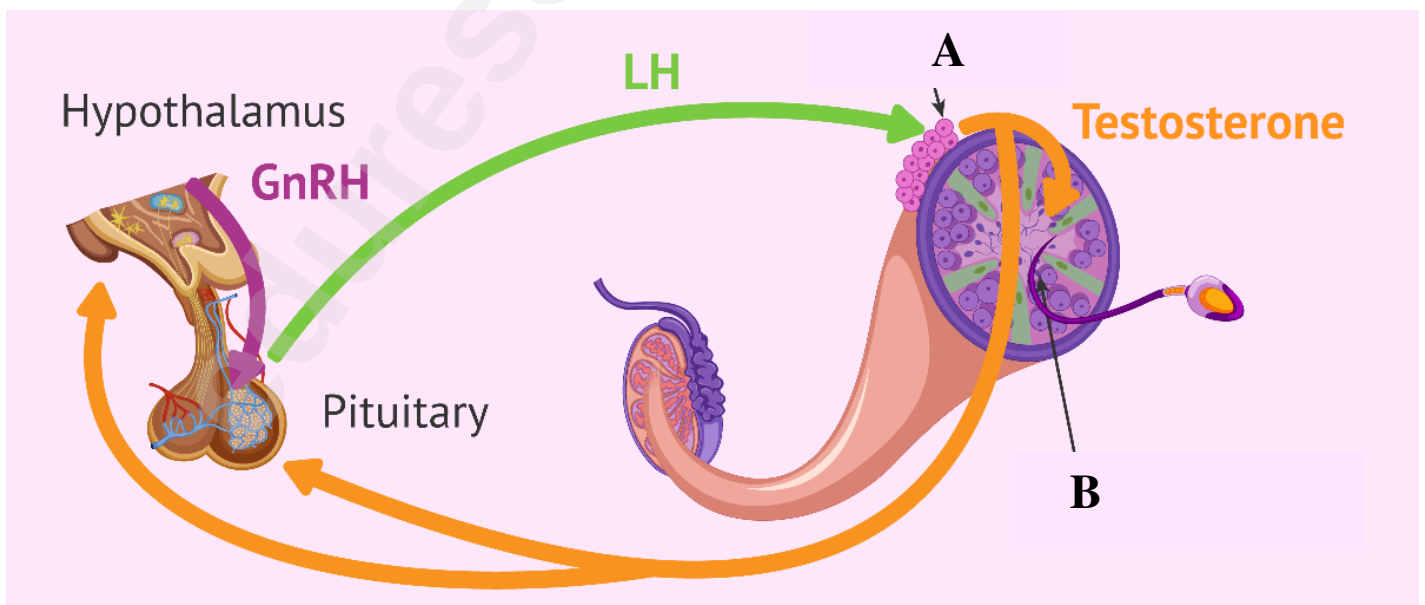
In women, AMH has a balancing effect on the monthly menstrual cycle and promotes the functioning of the follicle-stimulating hormone (FSH) and luteinizing hormone (LH) during the process of egg maturation and release (ovulation).

[Text adapted from: <yourhormones.info>]



[Image: <assignmentpoint.com>]

SOURCE E



[Image adapted from: <invitra.com>]

QUESTION 3

SOURCE A

Popularity of pug-like dogs 'could be fuelling rise in canine fertility clinics'

Investigation links boom in flat-faced canines to rise in clinics, some of which advertise banned procedures.



A pug and a French bulldog. Flat-faced dogs' breathing difficulties – a result of their ultra-short snouts – can also make it difficult for them to mate. [Photograph: <MightyPics/Getty Images/iStockphoto>]

The boom in popularity of flat-faced dogs such as pugs and French bulldogs may be fuelling a rise in canine fertility clinics, some of which advertise banned procedures, an investigation has found.

Dogs with squashed faces, known as brachycephalic dogs, are often unable to breed or give birth naturally due to their extreme anatomy: the animals' small hips can make mating difficult, meaning breeders turn to artificial insemination, while they also mean caesarean sections are often necessary since the puppies have disproportionately large heads.

The dogs' breathing difficulties – a result of their ultra-short snout – can also make it difficult for them to mate. Yet despite the risk of this and other problems, including skin and eye conditions, the clamour for such dogs has been huge. According to data from the Kennel Club, registrations of French bulldogs alone has risen from 1 521 in 2009 to 36 785 in 2018. Over the same period, the use of artificial insemination in dogs has also risen.

Services on offer at fertility clinics in the UK range from artificial insemination to ultrasound scans, sperm motility testing, microchipping, progesterone testing and, in some cases, caesarean sections. Loeb and colleagues found some of these clinics are linked to veterinary surgeries, while others are run through basic websites with limited contact details.

The researchers say the findings raise several concerns. Some procedures can only be carried out by a vet, including caesarean sections and artificial insemination involving transfer of sperm to the female's cervix. Loeb and colleagues note that while it is possible clinics without a vet may hire one for such procedures, it is not clear whether they do so.

What's more, the team found two clinics advertising an invasive form of artificial insemination that was banned in the UK last year. Upon contacting the clinics, they were told the website information was incorrect and would be removed. Loeb said the findings raise questions, including whether anyone is monitoring what happens in such clinics. "Unlike businesses that breed and sell dogs, those offering stud dogs, canine artificial insemination and ultrasound scans do not require a licence to operate," the report notes. "They are not generally regulated unless they offer services that are clearly acts of veterinary surgery."

In a linked editorial, Loeb writes that breeding flat-faced dogs using artificial insemination and caesareans may even be unlawful, pointing to regulations that say dogs should not be kept for breeding if their genes or other traits suggest breeding would harm the health or welfare of the parent or offspring.

But Bill Lambert, head of health and welfare at the Kennel Club, said artificial insemination is now used for many breeds and can bring genetic benefits, while non-vets can be very skilled in aspects of canine fertility that can be practised without veterinary qualifications. Professional support, he added, can help inexperienced breeders ensure safety and good conditions. "Where veterinary procedures are not involved then sometimes you can get extremely experienced people who are not vets, but they are maybe more experienced in certain areas," he said.

Daniella Dos Santos, president of the British Veterinary Association, said the organisation was deeply concerned about the advertising of banned procedures, adding that while other forms of artificial insemination are allowed and important for breeding, a vet should be involved in their use. That said, she stressed, the process is not suitable for all dogs – including those who cannot mate or give birth naturally. "We would be concerned about artificial insemination being used in such cases, or to allow dogs with inherited diseases and conditions, for example brachycephalic obstructive airway syndrome in flat-faced dogs, to be used for breeding," she said. "Vets will often recommend that these dogs are neutered."

[Adapted from:<<https://www.theguardian.com/lifeandstyle/2020/feb/07/popularity-of-pug-flat-nosed-dogs-could-be-fuelling-rise-in-canine-fertility-clinics#:~:text=Dogs%20with%20squashed%20faces%2C%20known,necessary%20since%20the%20puppies%20have>>]

SOURCE B

Why flat-faced dogs remain popular despite health problems.

Some veterinarians consider bulldogs, French bulldogs and pugs as having health and welfare too compromised to continue breeding, while owners of pets with chronic illnesses report greater psychological distress and a lower quality of life.

Packer and colleagues conducted the first large-scale study to explore owners' desires to reacquire or recommend the most popular brachycephalic breeds in the UK. Among the 2168 owners surveyed, 93% would choose to own their current breed again in the future, and two-thirds would recommend their current breed to a potential first-time dog owner.

Owners recommend their breed because of positive behavioural attributes for a companion dog, breed suitability for a sedentary lifestyle with limited space, and suitability for households with children.

Owners recommended against their breed due to the high prevalence of health problems, expense of ownership, ethical and welfare issues associated with breeding brachycephalic dogs, negative effects upon owner lifestyle and negative behavioural attributes.

The authors add: "Although dog breed popularity often follows a boom and bust pattern, our results are of real concern as they indicate that this 'brachy boom' is here to stay. Owners are becoming hooked on the loving personalities of these sweet dogs, but also accepting and normalising their shocking health issues."

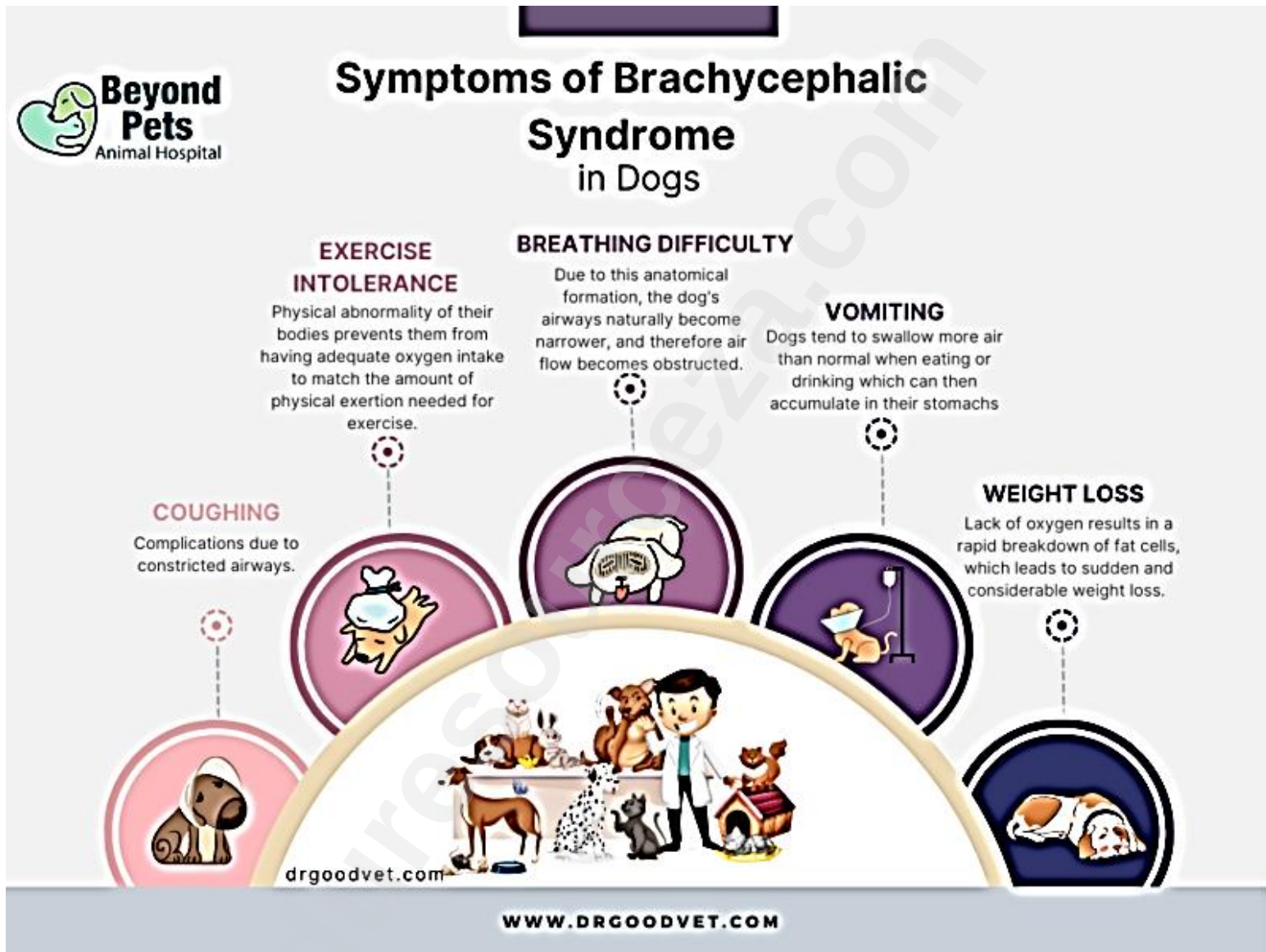
[Adapted from: <Rowena M. A. Packer, Dan G. O'Neill, Francesca Fletcher, Mark J. Farnworth. **Come for the looks, stay for the personality? A mixed methods investigation of reacquisition and owner recommendation of Bulldogs, French Bulldogs and Pugs.** *PLOS ONE*, 2020; 15 (8): e0237276 DOI: [10.1371/journal.pone.0237276](https://doi.org/10.1371/journal.pone.0237276)>]

These authors work at the Royal Veterinary College, UK.

SOURCE C

Understanding Brachycephalic Syndrome in Dogs

By Phil Good, DVM, March 1, 2023 Pet Health Plus



[Image:<<https://beyondpets.com/pet-health-plus/brachycephalic-syndrome-in-dogs/>>]

SOURCE D

Canine Brachycephaly: Anatomy, Pathology, Genetics and Welfare

[K. J. Ekenstedt](#),* [K. R. Crosse](#),† and [M. Risselada](#)‡



Fig. 1. Canine cranioskeletal shape. (A) Shetland sheepdog (dolichocephalic); (B) Labrador retriever (mesaticephalic); (C) bulldog (brachycephalic); (D) French bulldog (brachycephalic).

The brachycephalic phenotype was likely originally selected as a potential advantage in fighting, under the assumption that this craniofacial conformation resulted in increased biting forces; conversely, many of today's brachycephalic breeds are selected as companion dogs with appealing looks.

The increasing global popularity of breeds has been attributed to the distinctive physical facial characteristics selected for in brachycephalic dogs: a pedomorphic face resulting from a rounded skull, shortened rostrum, large forehead, large protruding eyes and bulging cheeks. It has been suggested that these infantile facial features trigger the same attraction, nurture response and positive emotions in adults that are aroused by a human baby.

[Adapted from: <Ekenstedt KJ, Crosse KR, Risselada M. Canine Brachycephaly: Anatomy, Pathology, Genetics and Welfare. J Comp Pathol. 2020 Apr;176:109-115. doi: 10.1016/j.jcpa.2020.02.008. Epub 2020 Mar 17. PMID: 32359622; PMCID: PMC7380493.>]

SOURCE E

Why PETA Says It's a Good Thing Bulldogs, Pugs Eventually Won't Exist.

Published January 24, 2023 by [Sara Oliver](#)



<https://katycable-68439.medium.com/is-the-beloved-pug-in-danger-of-extinction-6c9ceabf2111>

Bulldogs and pugs are breathing-impaired breeds (BIB) who, according to experts, may not exist for much longer. Due to the genetic diseases that are prevalent in BIBs, pugs, bulldogs, and others will likely reach a point where their health is so poor that they'll be unable to survive. Due to this constantly declining and already cruelly compromised quality of life, it would be best if these dogs no longer existed—and they shouldn't have been bred into existence in the first place. After watching her French bulldog suffer from debilitating health issues for years, one dog guardian told PETA, "I wish no more dogs would have to go through this": BIBs are known to suffer from brachycephalic syndrome, which leaves many of them struggling just to breathe while they engage in normal activities. Going for a walk, chasing a ball, running, and playing—the things that make dogs' lives joyful and fulfilling—are impossible for many breathing-impaired dogs.

Breeding BIBs such as English bulldogs and Cavalier King Charles spaniels is already restricted in Norway, because they're so prone to suffering that their existence was deemed cruel and in violation of animal welfare laws. And the Netherlands, which has also banned the breeding of certain BIBs, is considering prohibiting ownership of these animals and their use in advertising.

The Best Way to Help Is by Never Buying Any Dog—Adopt From a Shelter Instead

In light of all the suffering caused by breeding dogs to have flat faces, why do breeders keep doing this? Because people keep buying them—and because events like dog shows entice breeders to produce litter after litter in the hope of having a prizewinning dog they can then profit from by breeding and selling the dog's puppies. The breeding industry is big business, and as long as there is money to be made by selling, showing, and breeding dogs, greedy breeders will continue to produce more—regardless of how much they cause dogs to suffer in the process.

The solution is simple: Stop breeding and buying bulldogs, other BIBs, and any other dogs. All “purebreds” (flat-faced or not) suffer from congenital and often painful conditions. If you have the time, money, patience, and love to care for an animal for life (which could be for more than 15 years), please adopt one from a shelter. If you already have a breathing-impaired dog, please commit to making his or her life as fulfilling, healthy, and comfortable as you can—but pledge not to buy another one.

[Adapted from:<<https://www.peta.org/blog/bulldogs-and-pugs-will-no-longer-exist/>>]

SOURCE F

Flat-Faced Dog Breeds That Are Just So Precious

Originally Published: August 24, 2021 By [Juliana LaBianca](#)



From Boston terriers to bulldogs, these sweet pups—instantly recognizable by their short muzzles—will land a spot in your heart.

Even though flat-faced dogs could suffer from a range of health issues, still, we can't deny that these pups are majorly cute. Ahead, we've rounded up the sweetest dogs with flat faces that will win your heart.

1. Pugs

Who could resist these pint-sized, flat-faced cuties? These affectionate lapdogs were initially bred as companions for Chinese emperors. However, it didn't take long for the rest of the world to fall in love with these pups. The dogs are mischievous, charming, and often have startlingly human-like expressions that make bonding with them a breeze.



These pups make ideal modern-day pals for families with kids, singletons, the elderly, and everyone in between. Because of their flat faces and their resulting occasional breathing problems, they do best in moderate climates and would rather lounge on the couch than head on a hike.

2. Bulldogs

Dignified. Friendly. Chill. Those are just a few ways to describe a bulldog. Members of the non-sporting group, these pups were likely created in England in the 13th century for dog-fighting purposes. However, you'd never guess that violent history if you met a modern-day bulldog—the breed is now the national symbol of England and perfectly refined.



Today's bulldogs are the fifth most popular dog breed in the United States, beloved for their distinctive flat faces, loyalty, and adaptability (they can live in cities or more rural areas). The breed loves to relax but also enjoys a brisk walk. Because of their short muzzles and stature, they prefer more moderate temperatures and should never be left alone around stairs or water.

3. Boston terrier

The Boston terrier is another breed that originated in England's blood-sport arenas. Just like the bulldog, they rose above that violent past and became one of the most popular companion dogs in the world; they're the 21st most popular in the United States.



The pups, which are a cross between the bulldog and the now-extinct English terrier, are small in size and they are big in personality. Known for their friendly and lively dispositions, Bostons make fabulous city dogs and are always up for a walk in the square or an afternoon at a cafe. Their manners have even earned them the nickname "the American Gentleman." Their handsome tuxedo-jacket markings probably didn't hurt.

[Adapted from:<<https://www.rd.com/article/flat-faced-dogs/>>]

SOURCE G

🕒 10 Jun 2022

Share   

About 27% of SA's 14.9m dogs and cats don't have homes. That doesn't mean they don't have 'owners'.

Compiled by Larry Claasen

news24

 Comments

 Bookmark

State of Pet Homelessness Index – Index Results

South Africa 



Homeless Companion Animal Counts

4.1M

total
homeless
companion
animals

1.7M

street/stray cats

1.7M

street/stray dogs

650K

homeless cats & dogs in shelters

27% of companion animals in South Africa are homeless

4.1M homeless companion animals
14.9M total companion animals

[Image:,<<https://www.news24.com/news24/bi-archive/27-of-sas-dogs-cats-are-homelessness-but-that-doesnt-mean-they-dont-have-owners-2022-6>>]