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Heritage House

GRADE 12
PRELIMINARY EXAMINATION
SEPTEMBER 2019

Handwritten signature and date: 23/9/19

LIFE SCIENCES PAPER 2

Examiners: K East, P Schoombie
Moderators: M Hope, S Blampied, C Visser

Time: 2 Hours
Reading: 10 Minutes

Total: 100
Pupil:

Name and Surname: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 14 pages. Please check that your question paper is complete.
2. Read the questions carefully.
 - The question paper consists of **three** questions.
 - Question 1 and Question 2 are **case studies** and Question 3 is an **essay**.
 - Read the sources provided in the **Source Material Booklet** and use the information and your own knowledge to answer Questions 1 and 2.
 - Source material is also provided in the Source Material Booklet for the essay. Use this information and your own knowledge to first **plan** and then write your response.
 - All questions must be answered on the folio pages provided.
 - Please start each question on a **new page** and **leave lines open** between each sub question (e.g. 1.1 and 1.2).
 - Number the answers exactly as the questions are numbered in the question paper.
3. Use the total number of marks that can be awarded for each part of the questions in Question 1 and 2 as an indication of the detail required.
4. It is imperative that you write your answers **inside** the margins provided!
5. Demonstrate insight, where applicable, when answering questions.
6. Candidates are advised to pay particular attention to the use of language.
7. Use the total marks that can be awarded for each question as an indication of the detail required.
8. It is in your own interest to write legibly and present your work neatly.
9. **Good luck!**

Question 1

The Highveld Gerbil and Cape Gerbil are endemic to southern Africa. Both species have a diploid number of 44 chromosomes. A researcher investigated whether these two species were reproductively isolated. She put 16 pairs of gerbils into cages, with each pair being a male and female of different species.

Over the next 12 months, 18 hybrid babies were born. Nine babies died before they reached adult size. The nine babies that survived consisted of six females and three males. The hybrid males did not breed, but one hybrid female gave birth to a normal litter after she was paired with a normal male.

- 1.1. Identify the **term** from the source that has the following definition: (3)
- a) Offspring formed from two genetically different species.
 - b) A double set of chromosomes.
 - c) A species that exists only in a specific area.
- 1.2. Formulate an aim for the investigation from the source above. (2)
- 1.3. How could the validity of this investigation be improved by the researcher? (2)

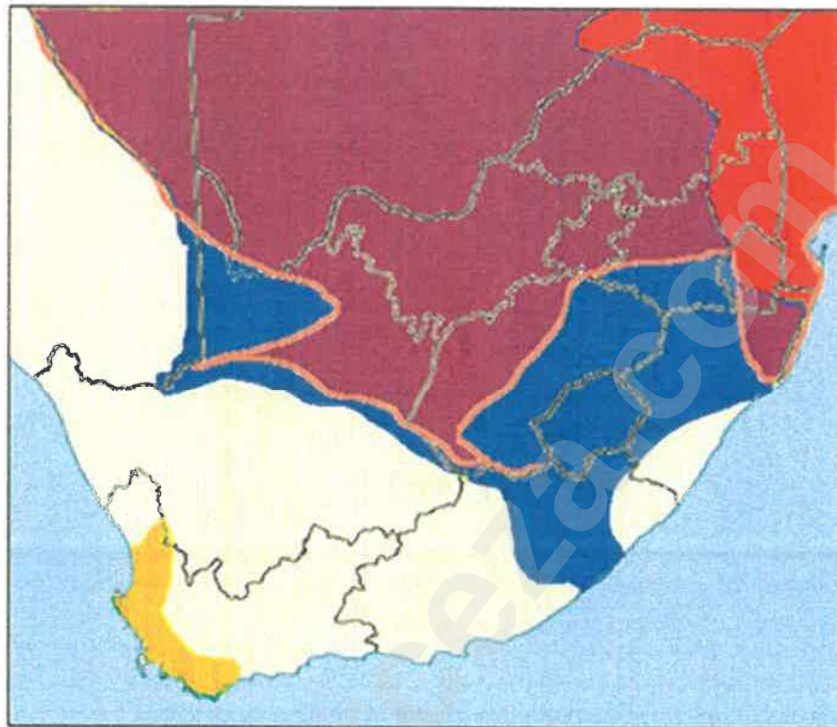
Habitats of the Highveld and Bushveld Gerbil.

The genus *Gerbilliscus*, consisting of 11 different species of Gerbils, is widespread in sub-Saharan Africa. The estimated age of divergence is from three to seven million years ago.

Bushveld Gerbil, typically occurs in open woodland, thornveld and bushveld, generally avoiding areas with less than 250 mm average annual rainfall. The Highveld Gerbil has a higher tolerance for dry conditions, can occur in areas with an average annual rainfall of less than 250 mm, and is typically found in vegetation ranging between grassland and open woodland.

The Highveld Gerbil mainly feeds on seeds from the maize plant. The Bushveld Gerbil's diet in the maize crop fields at planting consisted of seed and herbaceous plants and included insects during high summer.

Distribution of the Gerbils in Southern Africa

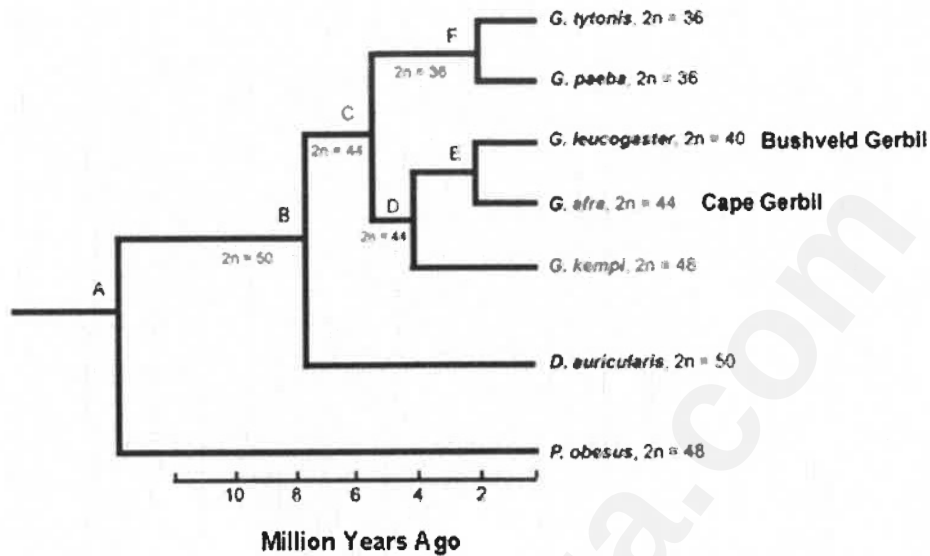


- Bushveld Gerbil
- Highveld Gerbil
- Bushveld and Highveld Gerbil
- Cape Gerbil

(Source: Grain SA. Gerbils - Ecologically based rodent management in maize. March 2016)

- 1.4. Distinguish between sympatric and allopatric speciation using the three species of gerbils as examples. (6)
- 1.5. Explain the role of isolating mechanisms in the evolution of new species. (4)
- 1.6. From the information given in the investigation, are the Highveld Gerbil and the Cape Gerbil really reproductively isolated? Explain your answer by using to quotes from the passage. (3)
- 1.7. Describe how the information given about the Highveld and Bushveld Gerbil illustrates adaptive radiation. (3)

Phylogenetic tree for West African Gerbils



(Source: Systematics and Phylogeny of West African Gerbils of The Genus *Gerbilliscus* (Muridae: Gerbillinae) Inferred from Comparative G- And C-Banding Chromosomal Analyses)

- 1.8. To which two species is *Gerbilliscus kempfi* most closely related? (2)
- 1.9. What evidence is there in this phylogenetic tree that this is an example of divergent evolution? (1)
- 1.10. What information would scientists use to predict the evolutionary relationships between species? (2)
- 1.11. Give the letter of the most recent common ancestor of *G. afra* (Cape Gerbil) and *D. auricularis* and state how long ago these two species are thought to have diverged? (1)

Total Question 1 [30]

Question 2

Genetic Disorders hit Amish Hard

By Mary-Jayne McKay, CBS February 11, 2009, 7:21 PM

The Amish children have medical conditions so rare, doctors don't have names for them yet.

Nearly 150,000 Amish in America trace their roots back to a few hundred German-Swiss settlers who brought the Amish faiths to the United States in the 18th century. Over generations rare genetic flaws have shown up.

Using a genealogy web site one of the parents of the girls' suffering from Cohen Syndrome, figured out she and her ex-husband were distantly related, something that appears to be common among the Amish.

Doctor Harold Cross, who's from an Amish background himself, has been studying the high incidence of genetic problems in the Amish. "Although we used state-of-the-art medical and genetic technology at the time in the 1960's," he says, "we didn't know about the human genome. He's finishing the job now, learning by examining some of the children in the Ohio Amish community, and teaming up with researchers in a London lab to find the actual genes that are causing the Amish disorders.

There are no cures in sight yet, but these doctors can offer the next best thing: pre-marital testing, to help future parents avoid these tragedies. It's a powerful new tool for the Amish, *if* they choose to use it.

Despite the illnesses in his family, Miller would not use such tests. "That's our lifestyle. We trust God to take care of that, you know? It's just the way we live."

Marrying outside the faith could create a healthier gene pool, but it would also ultimately destroy the very essence of what it means to be Amish.

2.1. State **True** or **False** for each of the following:

(3)

- a) The increase in 'rare genetic flaws' amongst the Amish is due to the Bottleneck effect.
- b) The process to 'find the actual genes that are causing Amish disorders' is called gene sequencing.
- c) Genealogy is the study of your ancestors and your line of descent.

2.2. Explain in detail why pre-marital testing would be considered as a 'powerful tool for the Amish'?

(4)

Use the following terminology in your explanation:

inbreeding, gene pool, recessive genes, gene frequency.

2.3.

Crispr Cas 9 is a DNA editing tool. It uses the Cas9 enzyme to make double strand cuts in the DNA. It can be used for inactivating a gene and for gene therapy.

2.3.1. Explain how genome analysis and Crispr can be used to help the Amish? (2)

2.3.2. Could the use of this technology result in evolution amongst the Amish community? Explain your answer. (2)

2.4. Due to their cultural beliefs it will not be easy for the Amish to overcome and reduce this high prevalence of genetic disorders amongst their community. Using one Amish cultural belief explain why this is a valid statement? (2)

Moroccan fossil find rearranges *Homo sapiens* family tree

The findings, announced in *Nature*, fill a crucial gap in the human fossil record. That's because these people bear many striking similarities to modern humans even though they lived well before what may be the oldest fossil evidence of *Homo sapiens*, from a site in Ethiopia dated to about 195,000 years ago.

Two studies published in the journal, *Nature*, extended our species' recorded existence by a third, from 200,000 to 300,000 years ago, and disputed the long-held theory that we emerged from an East African "cradle of humankind."

Homo sapiens sharing Africa with other Hominin species

This unveiling of the oldest-known *Homo sapiens* remains has also painted a picture that Earth, 300,000 years ago was bustling with hominin species that included a very early version of our own, experts say. The origin of our species likely involved numerous populations spread across Africa with periodic gene flow between them.

Garden of Eden Theory

Rather than emerging from a single "Garden of Eden"; an area where our species first developed and spread from, it seems early modern humans were already scattered across the Mother Continent a hundred millennia earlier.

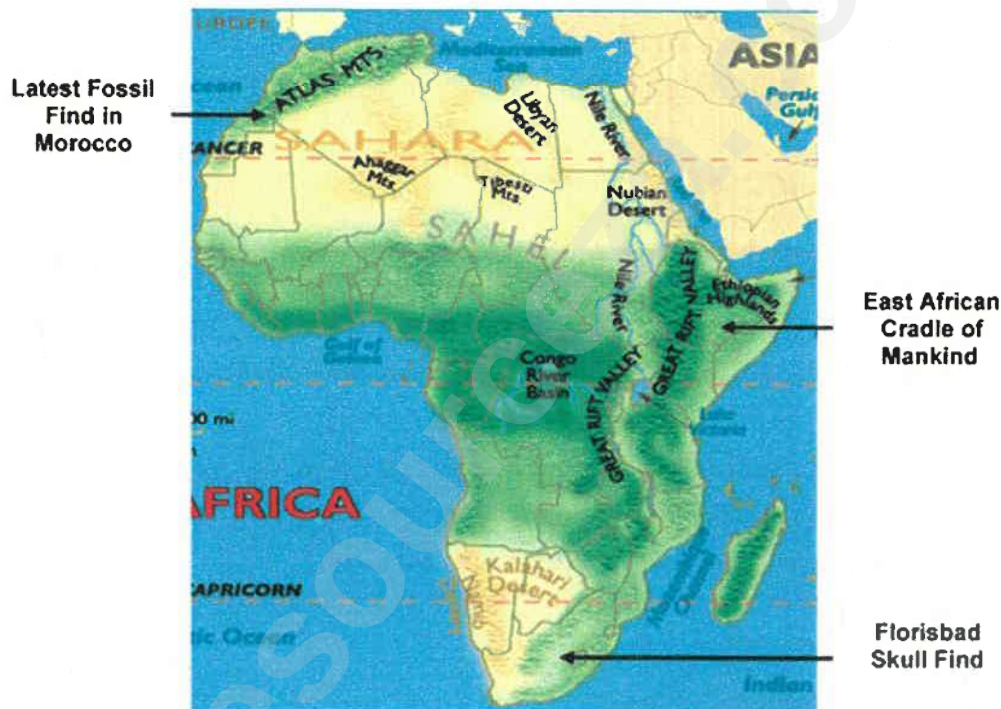
Timing of Out of Africa Hypothesis possibly questioned

Another unknown is when our species started encountering members of *Homo* groups from further afield—Neanderthals from Europe for example.

Physical Features

Analysing the sizes and shapes of the bones found in Morocco, the researchers found that the form of the face, lower jaw and teeth was different from Neanderthals and other archaic humans. In these features the Moroccan remains resembled *H. sapiens*. The braincase, however, lacks the round shape characteristic of modern humans which can be associated with differences in brain organization, a defining characteristic of 'our' species.

All things considered, the team concluded the Moroccan remains represent "the very root of our species, the oldest *H. sapiens* ever found in Africa or elsewhere.



(Adapted from Articles from phys.org by Mari tte Le Roux and National Geographic by [Michael Greshko](#), June 2017;
Journal reference: [Nature](#))

Ancient Fossils from Morocco Mess Up Modern Human Origins

Not everyone is ready to accept the claim that the Moroccan fossils necessarily belong to *H. sapiens*. Paleoanthropologist John Hawks, says their modern-looking traits might not actually reflect a connection to our species. He notes that the analysis by others did not compare the Moroccan remains with fossils from Spain dating to more than 800,000 years ago that belong to a species called *H. antecessor* these have characteristics that resemble modern humans in many ways, and are a lot older than the Moroccan fossils," he says.

Hublin has stated that the findings do not imply a move away from the cradle of modern humankind. Instead, taken together with other fossil discoveries including a skull with some modern characteristics from Florisbad, South Africa, which was dated to 259,000 years ago. They suggest the emergence of *H. sapiens* was a pan-African affair: by 300,000 years ago, early *H. sapiens* had dispersed across the continent.

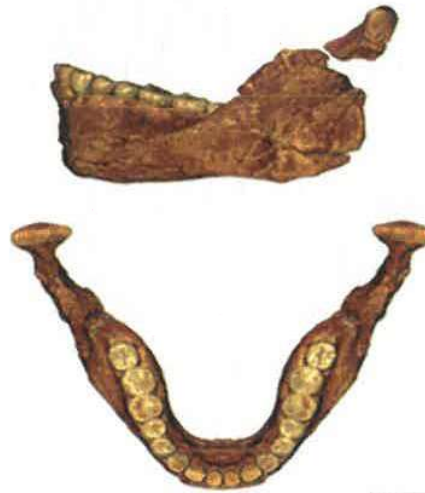
(Adapted from Scientific American: by Kate Wong)

- 2.5. Explain the Out of Africa Hypothesis on the origins of modern humans. (5)
- 2.6. Science is constantly changing, and new evidence is being discovered. How does the Moroccan fossil discovery lead to scientists needing to revise their previous theories? Discuss two theories that may need amending and suggest the necessary changes. (4)
- 2.7. Explain the concept Cradle of Humankind. (1)
- 2.8. In modern day Africa what physical/geographical barrier would have prevented the possibility of this so-called 'Pan-African affair', which is 'the spread of numerous populations across Africa with periodic gene flow between them'? (1)
- 2.9. Evaluate whether these Moroccan fossils really are the earliest form of *Homo sapiens* against contesting theories represented in the sources. Use the source as well as these images below of fossil specimens found or reconstructed. (4)



The reconstructed composite of the Moroccan fossil skull.

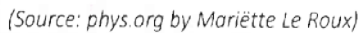
Credit: Philipp Gunz, MPI EVA Leipzig



Lower jawbone from Moroccan is nearly complete.

Credit: Jean-Jacques Hublin, Leipzig

- (2)



[30]

[40]

Question 3

While humans may artificially enhance or repress an organism's genetic traits through artificial selection, nature concerns itself with traits that allow advantages to a species' ability to mate and survive. People have experimented with artificially breeding organisms to boost traits only beneficial to mankind, even if those traits did not give a species a mating or survival advantage.

(Source: sciencing.com)

Do you agree with the statement that natural selection ONLY gives species an advantageous ability to mate and survive and artificial selection is ONLY for the benefit of humankind and is disadvantageous for the species?

Using the source material provided as well as your own knowledge, discuss your opinion on the above statement in the form of a 2½–3-page essay.

To answer this question, you are expected to:

- Read the source material carefully and present a debated argument to illustrate your point of view.
- Select relevant information from sources A to H below.
- It is important to integrate your own relevant biological knowledge.
- Take a definite stand on the question and arrange the information to best develop your argument.
- Write in a way that is scientifically appropriate and communicates your point of view clearly.
- Provide a clear **plan** of your essay before you start writing. Note that the plan will be marked as part of the assessment of this question.

Source A

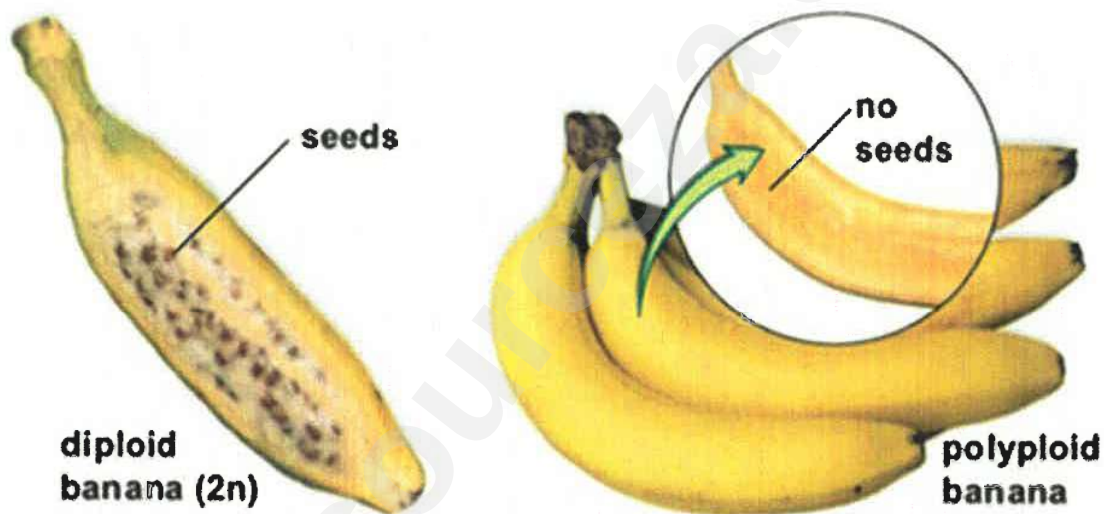
Mosquitos develop resistance to DDT

DDT was introduced as a pesticide in the 1940's. Within a few years, many insects in different parts of the world had become resistant to it. In Nigeria, the *Anopheles gambiae* mosquito which is a vector for malaria, was one insect that evolved DDT resistance. However, in villages that had never been sprayed before, almost no mosquitos were resistant.

(adapted from Advanced Biology, Kent 2000)

Source B

Farmers breed polyploidy fruit plants



Source C

Compare and contrast natural selection and artificial selection

In the current breeding of bulldogs, they are being selected by man to have large heads, which requires them to be born by caesarean section. Dobermans are a breed of dog that has also been bred for a certain appearance. In the process of selecting for this appearance, a genetic defect has increased in frequency in the population. This defect causes narcolepsy, a condition that causes these dogs to uncontrollably fall into deep sleep. These would obviously not be traits selected for in nature, as it would decrease species fitness.

Breeders who seek to encourage certain desirable traits, may unintentionally reproduce traits detrimental to the animal's health. For example, for economic benefit, farmers may breed cows with large udders to increase

their offspring's milk yield. This has often made a mother bear for the sake to bear and cause great discomfort.

When man selects organisms to breed for specific traits, many times he selects related members to enhance that trait. An example is the inbreeding that occurred during ancient times and more recently amongst European royals. To preserve royal lineages, relatives were often allowed to marry and produce children.

Inbreeding can also occur in natural selection, particularly when populations are small.

(Taken from sciencing.com)

Source D



Natural selection does not grant organisms what they "need".

(taken from online bio text)

Source E

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Sexual selection in Widow birds

Selection makes many organisms go to extreme lengths for sex and develop traits that are in fact useless for survival.



Sexual selection is often powerful enough to produce features that are harmful to the individual's survival. For example, extravagant and colourful tail feathers of the male Long-tailed Widow birds. The tails are prominently exhibited as the male flies slowly in aerial display over his territory. This can be seen from more than half a mile away. The females, in contrast, have short tails and are inconspicuous. These tails can also result in the male bird losing balance.

Each male establishes a territory on the grasslands and mates with several females that nest within their defended domain. "Females sometimes visit several males in rapid succession with ample opportunity for comparisons," Swedish ornithologist Andersson wrote in a 1982 paper in [Nature](#).

(Adapted from an article written by [Rex Graham](#), owner of Top Birding Tours and Understanding Evolution, from <http://evolution.berkeley.edu>)

Source F**Sickle Cell Anaemia and Malaria**

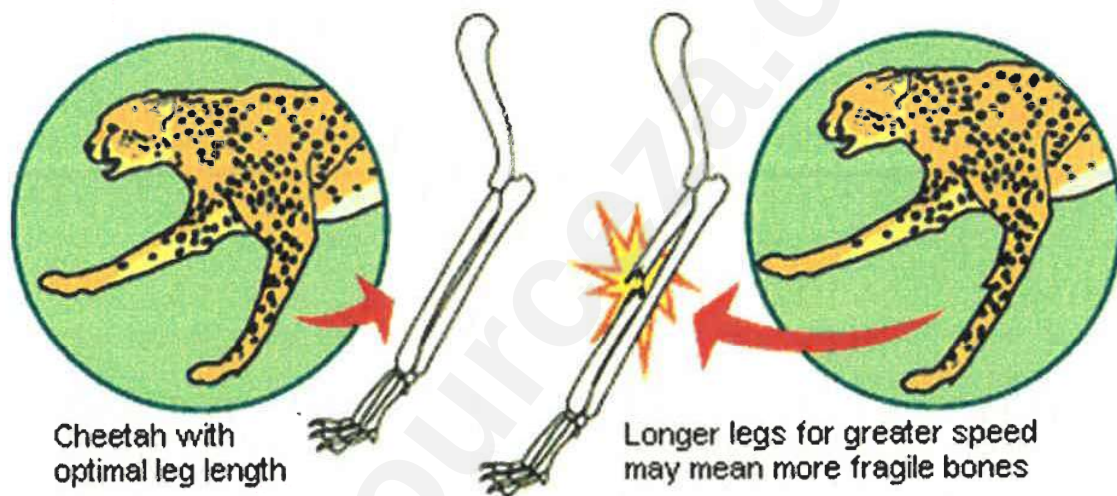
We would expect natural selection to remove alleles with negative effects from a population and yet many populations include individuals carrying such alleles. When carrying two copies of an allele is disadvantageous but carrying only one copy is advantageous. For example, the allele that causes sickle cell anaemia is a disadvantage if you carry two copies of it, as you are not able to carry oxygen efficiently. However, if you only carry one copy of it, you may develop mild anaemia but by large you can live a normal life. These people can live in a place where malaria is common, the allele is advantageous because it results resistance to malaria. In areas of increased malaria, the gene for sickle cell anaemia increases in frequency.

(taken from Understanding Evolution, from <http://evolution.berkeley.edu>)

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Source G**The trade-off of the Cheetah's speed**

Changing one feature for the better might change another for the worse. Perhaps faster alleles exist in the cheetah population — but there is a trade-off associated with them: the alleles produce cheetahs with longer legs (and hence more speed), but these long legs are hazardously delicate. Although longer limb bones increase stride, their chances of failing, due to bending loads increases as well. In this case, perhaps no net increase in fitness would result from the faster alleles.



Trade-off between the safety factor and length of limb bone

(taken from Understanding Evolution, from <http://evolution.berkeley.edu>)

How do so many varieties of cruciferous vegetables exist?

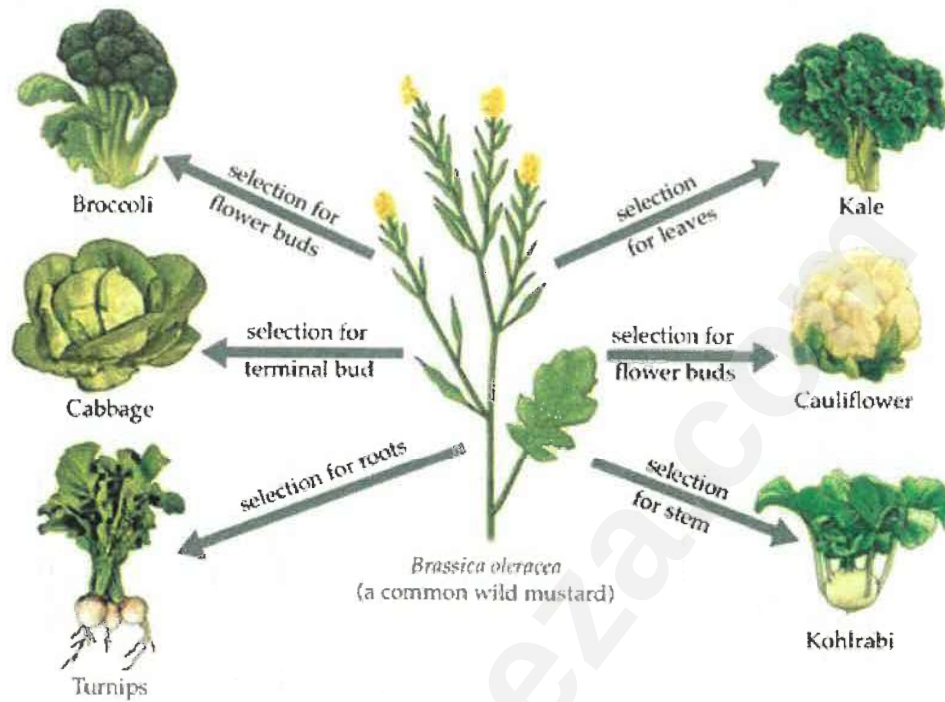


FIGURE 1.10 Evolution of Wild Mustard through Domestication

In artificial selection, humans are the selective agents. The many different varieties of cruciferous plants were created by humans through selective breeding of genetically varied wild mustard plants. Individuals with desired genetic characteristics were bred with each other until their descendants became distinctly different from the ancestor, the wild mustard.

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