Genetics – questions

1. The colour of a tomato can be represented by RR, Rr or rr. Why do we use capital letters for some symbols and lower case letters for others? Why are there two symbols for one trait (characteristic)?
2. B stands for black coat colour in horses, b stands for chestnut.
   a) Give the genotype (genetic code) for a homozygous black horse.
   b) Give the genotype (genetic code) for a heterozygous black horse.
   c) Give the genotype (genetic code) for a hybrid black horse.
   d) Show the possible genetic combinations of the offspring in the following cross.

	B	b
B		
b		

Show the possible genetic combinations in the offspring.

3. Using the above same information, if two horses produced two black foals and one chestnut foal, what are the possible genotypes of the two parents for this particular trait?
4. A pure bred black dog (BB) is crossed with a brown coated female and all the pups of their litter have black hair. Explain how this can occur.
5. i) If dull green foliage (leaves) in broccoli is dominant to glossy foliage, with G being the gene for dull green, work out the expected genotypes (genetic code) and phenotypes (appearance) with their expected proportions from the following matings.
      a) pure dull green foliage x pure glossy foliage.
      b) hybrid dull green foliage x pure dull green foliage.
      c) pure glossy foliage x hybrid dull green foliage
      d) pure glossy foliage x pure dull green foliage.
   ii) Why was the following question not included in the above?
      hybrid glossy foliage x hybrid dull green foliage.
6. In a cross between two chickens, 12 of the chicks are black while 36 are white. If white is dominant to black, predict the possible genotypes of the parents using a punnet square.
7. A rooster with red plumage (rr) is crossed with a hen heterozygous for plumage colour. (Black plumage is dominant).
   a) What is the probability that a particular sperm contains an R gene?
   b) What is the probability that a particular sperm contains an r gene?
   c) What is the probability that a particular egg contains a gene for red plumage?
   d) What is the probability that a particular egg will contain an R gene?
   e) What is the probability that a particular offspring has red plumage?

f) What is the probability that a particular offspring is hybrid?

g) What proportion of the offspring in a brood of chickens would you expect to have black plumage?

8. In guinea pigs, the contrasting traits are black and white coat colour. The gene for black is dominant in these animals.

   Consider a cross between a homozygous black guinea pig and a homozygous white one. All the F1 offspring are heterozygous black. What happens if two of these hybrid animals are crossed?

   Draw a punnet square and work out

   a) the probable genotypes, and

   b) the probable phenotypes of the offspring.

9. A brown mouse and a black mouse mate, producing only black offspring. Show why no brown offspring are produced.

10. In cattle the polled (hornless) characteristic is dominant to horned. If a homozygous horned cow is crossed with a polled bull -

    a) What are the possible genetic codes for the calves.

    b) What percentage of the possible offspring could we predict will have horns?

    c) What percentage of the possible offspring could we predict will be hornless?

    d) What percentage of the possible offspring could we predict to be pure strained cattle?

11. Brown coat is dominant to white coat in rabbits. If a homozygous brown rabbit is crossed with a homozygous white rabbit, predict the percentage of offspring that will be white.

12. If a heterozygous brown rabbit is crossed with a homozygous white rabbit, what percentage of offspring will be white? Explain your answer.

13. In a species of daisies, yellow flowers are dominant over white flowers. Using Y to represent yellow and y to represent white, draw a punnet square to show a cross between a yellow flower and a white flower where the offspring are 50% yellow and 50% white.

14. Using the above information, if two hybrid yellow flowers are crossed, show using a punnet square, the ratio of yellow flowering offspring to white.

15. Hair length in rabbits can be either short (dominant) or long (recessive). If a heterozygous short haired rabbit was crossed with a long haired rabbit, predict the expected ratios of short haired to long haired offspring. Show your workings.

16. What is a hybrid?

17. A champion horse is described at a sale as purebred. What does this mean?

18. In cocker spaniels, black colour is dominant to red. If two cocker spaniels produce 9 red offspring and 27 black, predict the possible genotypes for the parents.

19. A pure strain long-haired guinea pig is crossed with a pure strain short haired guinea pig. If short hair is dominant, what percentage of any offspring could we predict will have long hair?

20. In rabbits, albinism is a recessive trait. If two rabbits heterozygous for albinism were crossed, how many normal and how many white rabbits would you expect out of a litter of 13?

21. A pure strain bronze turkey is crossed with a pure strain red turkey. They have 8 offspring. If bronze is dominant what colour are the first four? Explain your answer.
22. A rose comb is dominant to a single comb in chickens. If a heterozygous rose combed rooster was crossed with a single combed hen
    a) what would be the genotypes of the offspring?
    b) what would be the ratio of each genotype?
    c) what phenotypes would you see in the offspring?
    d) what would be the predicted phenotype ratio?
23. A heterozygous red eyed fruit-fly is crossed with another heterozygous red eyed fruit-fly. They produce 4 offspring only and all of these have white eyes. Explain.
24. Wire hair dominates over smooth hair in dogs. Using W to represent wiry hair and w to represent smooth hair, predict:
    a) the possible gene combinations that could result when a homozygous smooth haired dog is crossed with a heterozygous wiry haired dog.
    b) the theoretical percentage of wiry haired pups.
25. A dog breeder has a black female cocker spaniel and he is not sure if it is homozygous for the trait, or heterozygous. Which of the following crosses would be the best way to find out? (Note that red is the recessive. Explain your answer.)
    a) breed the dog with a male known to be homozygous black
    b) breed the dog with a male known to be heterozygous black
    c) breed the dog with a male known to be homozygous red.
26. In sheep, white wool is dominant to black wool. Show the expected genotypes and phenotypes of a cross between a heterozygous white sheep with a black one.
27. Black feathers are a dominant characteristic in hens, the recessive character being red feathers. A farmer kept only 7 hens, one of which was red (i.e. one-seventh of the total). His neighbour had fifty hens, twelve of which were red. Explain the proportion difference.
28. Tomatoes can have red fruit colour, which is dominant, or they can show the recessive colour, yellow. If two red tomatoes produced some yellow offspring, predict the genotypes of the two parents, using a punnet square.
29. A curly haired man mated with a straight haired female. In humans, curly hair is dominant to straight hair. If they had eight children, how many of them would you expect to be curly haired
    a) if the father was homozygous for the trait?
    b) if the father was heterozygous for the trait?
30. Explain how a heterozygous curly haired man and a heterozygous curly haired woman could have four straight haired children.
31. If large ears are dominant to small ears in humans, show using a punnet square how two large-eared parents could have a child with small ears. How likely is this to occur? (i.e. What is the probability of this happening?)
32. If a first child inherits the recessive trait of having no freckles from his parents, both of whom have freckles, what are the chances of a second child having no freckles? The third child? Fourth child?

33. A person with no pigment in their skin is called an albino. This is a recessive inherited trait in humans. If an albino man mates with a normal woman who had an albino parent, what is the probability that their first child will be an albino?
34. Define the terms: alleles, homozygous, heterozygous.
35. Bell-shaped squash (a vegetable) result from a cross between a long squash and a round squash. What does this indicate? Explain your answer.
36. What is the difference between codominance and incomplete dominance? Use examples to explain your answers.
37. What do you think makes a gene dominant?
38. Why are short lived animals such as drosophila flies useful for genetics experiments?
39. In what way has a knowledge of the principles of heredity benefited humans?
40. Describe the process of artificial pollination.

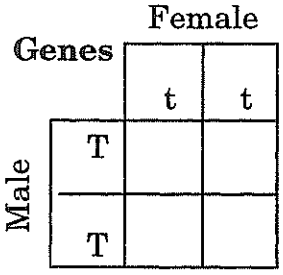
Activity – the punnet square

The punnet square is a special grid system which shows the possible gene pairings resulting from crossing different parents. It also gives the probability (or likelihood of it happening) for each gene pair.

Fill in (a) the parent genes and

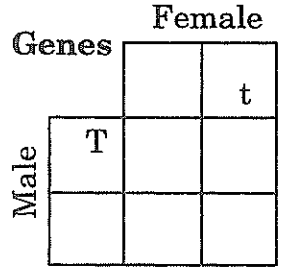
(b) the possible pairings for each combination of genes in the punnet squares below. They are all examples of **Monohybrid crosses** (one character only) for tall (T) and short (t) plants.

1 Crossing TT and tt



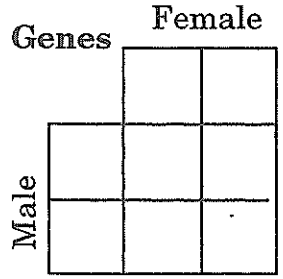
	No	Ratio
Possible genotypes		
Possible phenotypes		

2 Crossing Tt and Tt



	No	Ratio
Possible genotypes		
Possible phenotypes		

3 Crossing Tt and Tt



	No	Ratio
Possible genotypes		
Possible phenotypes		

4 Crossing Tt and tt

	No	Ratio
Possible genotypes		
Possible phenotypes		

Draw your own Punnett Square.

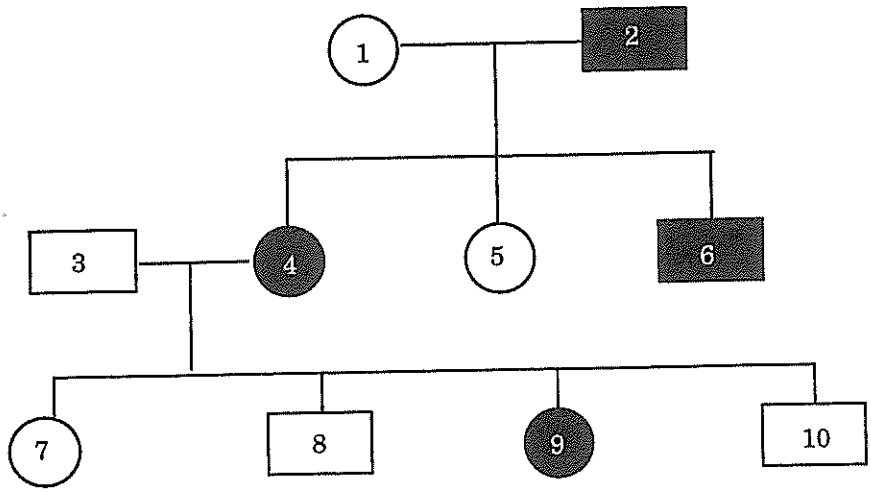
- See if you can label each genotype either dominant/recessive heterozygous/homozygous.

Human genetics

Questions

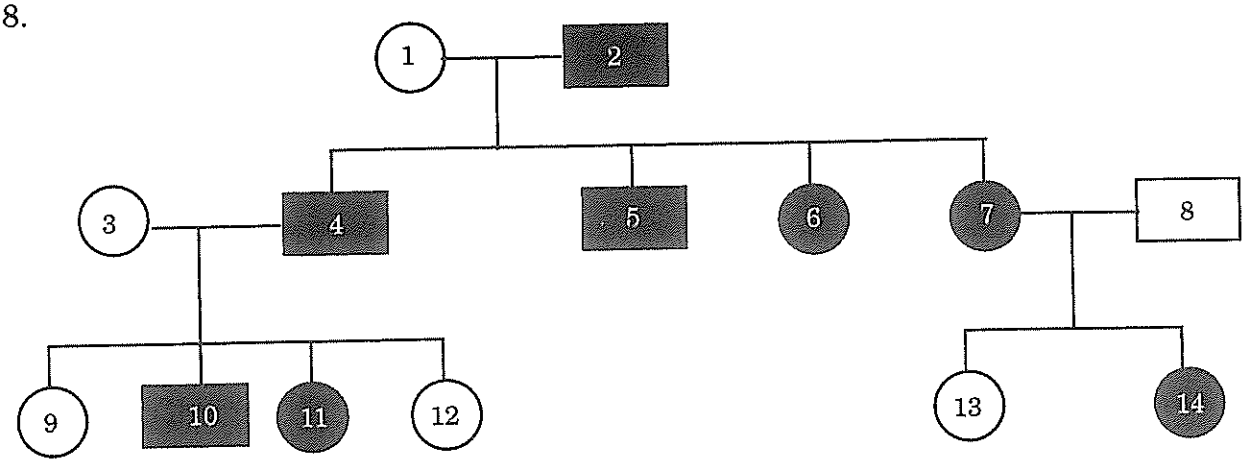
1. What is Down's Syndrome? How is it caused?
2. How does the chance of having a child with Down's Syndrome change as the mother gets older? Does the father's age affect the possibility?
3. The gene for the hereditary disease Spina Bifida is recessive. If a man with this disease mates with a normal woman with no history of the disease in her family and the couple seek genetic counselling about the probability of their having a child with the disease, what will they be told?
4. Explain how sex is inherited in humans.
5. Draw a pedigree of your own family, including relatives, showing any eye disorders (long and short sightedness). With the knowledge that these conditions are caused by dominant genes, see if you can determine genotypes for each family member for these characteristics.
6. Draw a pedigree of your family for tongue rolling ability which is caused by a dominant gene.
7. Why do you think a colour blind person may not be aware of his/her condition?
8. Can a woman who is red/green colour-blind and mates with a man who is not colour-blind have normal sons? Give a reason for your answer.
9. If red/green colour-blindness is inherited via a recessive and X-linked gene, what are the possible offspring from (a) a colour-blind father and a carrier mother?
   (b) a colour-blind mother and a normal father?
   (c) a normal mother and a colour-blind father?
10. In the Drosophila fruit fly the gene for red eyes is dominant, while the gene for white eyes is recessive and X-linked (X^r). What possible phenotypes and genotypes will result from a cross between a white eyed male (X^rY) and a homozygous red eyed female (X^RX^R)?
11. Using the same information for the above question, work out the possible genotypes and phenotypes of a cross between a red eyed male ($X^R Y$) and a white eyed female (X^rX^r).
12. Researchers are in the process of developing cures for many hereditary diseases. Some people may argue that 'nature's way' of keeping the population down should not be interfered with. What do you think?
13. Potential cures for many inherited diseases are often delayed because of legal restrictions regarding experiments on humans rather than laboratory animals. Do you think there is a case for people with diseases volunteering to be human 'guinea-pigs' in such experiments? Explain your answer.
14. Do you think people with genetically inherited diseases should be legally prevented from having children? Give a reason for your answer.
15. Through gene therapy techniques, scientists are genetically altering the cells of a diseased patient and putting them back into the patient's body. What implications does this technology have for the future, outside the area of medicine?
16. Is it possible for a characteristic dependent on a dominant allele to 'skip a generation' (not appear) in a human pedigree? Draw a pedigree chart to explain your answer.

17.



The above pedigree shows an example of the inheritance of a dominant gene characteristic (B) in a family over 3 generations. What are the genotypes of (1), (3) and (8)?

18.



The above pedigree is another example of dominant gene inheritance.

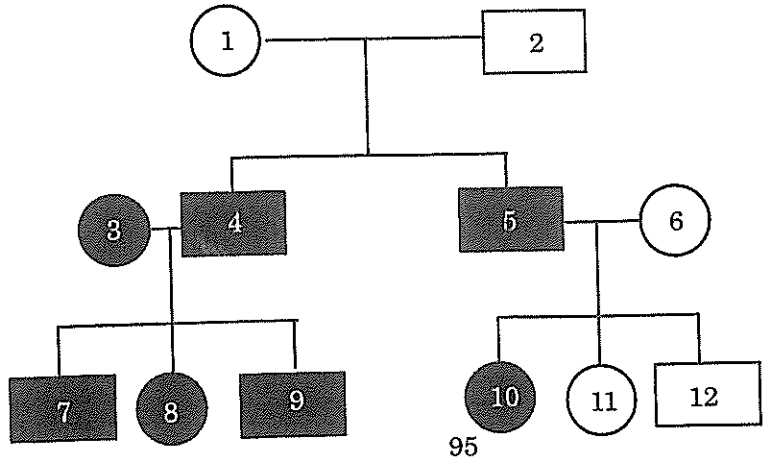
a) What are the genotypes of (1) and (3)?

b) What is the likely genotype of (2)? Explain your answer.

c) What is the genotype of (7)?

d) What possible genotypes does (11) have?

19. This is a pedigree showing inheritance of a recessive gene.

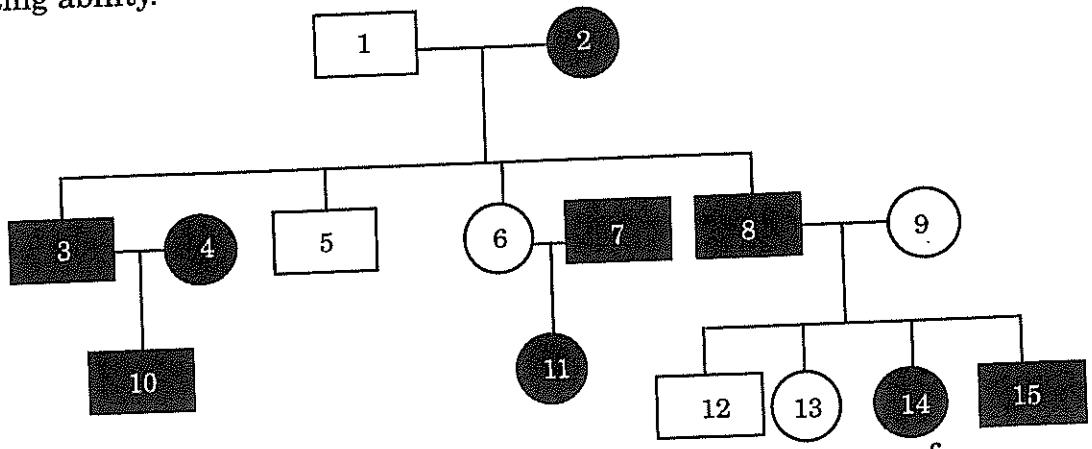


a) What are the genotypes of the parents?

b) What genotypes do (4) and (5) have?

c) What is the genotype of (3) and (11)?

20. Human beings differ in their ability to taste phenyl-thiocarbamide (PTC) paper. Some find it has a bitter taste while others find it to be tasteless. Tasting (T) is dominant to non-tasting (t). The following pedigree shows the inheritance of PTC tasting ability.



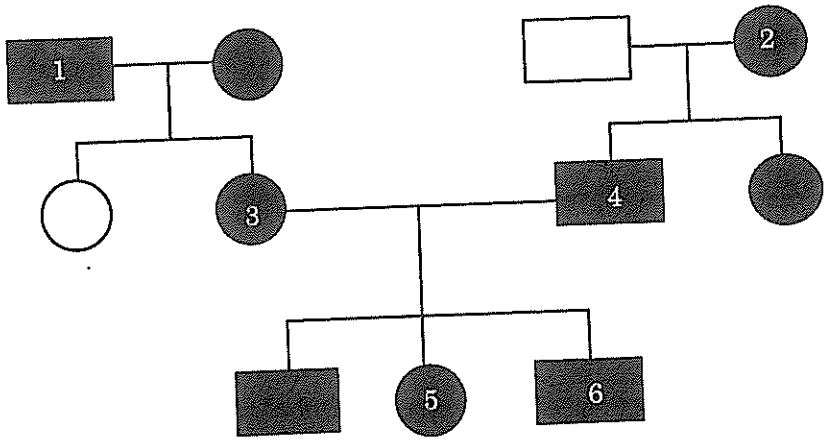
a) Which person could be either homozygous or heterozygous for T (2, 14, 8 or 10)?

b) What are the chances of 11 having a child who is a taster if she mates with 15?

c) What are the chances that a second child of couple 6 and 7 is a taster?

d) Which of the following genotypes is incorrect: 2 - Tt; 5 - tt; 15 - rr; 11 - Tt?

21. The following is a pedigree showing inheritance of tongue rolling in two families where R represents rolling and r represents non-rolling.



a) The genotype of 3 is: (a) RR (b) Rr (c) rr (d) RR or Rr.

b) Which two individuals have identical genotypes? 1,2; 1,3; 1,4; 2,3.

c) Which genotype may be wrong? 1 - Rr; 2 - RR; 4 - RR, 6 - Rr.

d) If 3 and 4 had another child, what would be the probability of it being a non-roller?

Population genetics – Questions

1. What is a gene pool?
2. Which are the factors that can change the frequencies of particular genes in a population?
3. What can the study of blood types amongst different racial groups (e.g. the Australian Aboriginals) tell us about the origin of groups of people?
4. What is the difference in the meanings of the terms genotype and gene pools?
5. Can you think of an example of a situation where the Hardy-Weinberg principle would apply in a population? Why do you think such a principle was developed by research biologists?
6. What might happen to the gene pools of two populations which, before being separated geographically, were once a single population?
7. Give examples of 'geographical barriers' which may isolate populations and prevent gene flow.
8. Is it possible for a blood Type A father and any blood Type O mother to have a child with Type B blood? Show your reasoning.
9. A father with Type O blood and a Type AB mother will produce a child with which blood type? Explain your reasoning.
10. An adopted baby with Type O blood spent years trying to locate her real mother. She eventually narrowed the search to two women—one with Type A blood and one with Type AB. Which woman was the most likely to be the mother? Explain.

Natural Selection

1. What is a mutation? What types of mutation are possible?
2. List some of the factors which may cause mutations.
3. Do you think the rate of mutations has remained constant in the last century or do you think it may have increased or decreased? Give reasons for your answer.
4. Do you think a mutation resulting in an albino plant would be a useful one? Explain.
5. Why are most mutations harmful?
6. What are the causes of variation in a population?
7. A short legged sheep suddenly appeared in a farmer's flock. How would the farmer find out if it was due to a mutation or due to the environment?
8. What does 'adaptation' mean? Give examples of two animals and two plants which have adapted to their natural environment, describing several of the adaptations of each.
9. What is meant by natural selection?
10. Describe an example of where natural selection has occurred in the animal kingdom.
11. Amongst which group of animals would natural selection be easier for a scientist to observe – bacteria or lions? Explain your answer.
12. Give examples of changes in an environment.
13. What is the relationship between variation in a population and environmental change?

14. If variation in a species is the key to a species' survival, why do you think species which produce only asexually and therefore show little variation have not all become extinct?
15. Is a stable environment or a changeable environment more likely to result in gene pool changes in populations? Give reasons for your answer.
16. Explain the phrase 'survival of the fittest'.
17. Which do you think came first – Heptachlor, an insecticide used to spray houses, or wasps resistant to Heptachlor. Give reasons for your answer.
18. Why do you think companies which make successful chemicals such as the insecticide DDT, employ so many chemists to research improved chemicals?
19. Mice are normally killed by rat poison. However some mice may not be killed by the products and the numbers of resistant mice may be seen to be on the increase over a period of time. How would you explain this situation?
20. What is biodiversity?
21. How do you think 'global warming' in the future might affect organisms in a population?
22. Why is biodiversity an important part of natural selection and the survival of a species?
23. Inbreeding can cause a gene pool to shrink to a gene 'puddle'. Why is this?
24. How can zoos, which have extremely small populations of different species, prevent inbreeding and decreases in biodiversity which would lead to the demise of such populations?
25. Do you think conservation of species is important? Explain your answer.

Practical exercise – gene pools

A gene pool refers to all the genes in a population of organisms. Examples would be the sum total of the genes in the magpie population in the S.W. of Western Australia and every gene in every cane toad in Australia.

Australian Cane Toad

Aim:

1. To investigate the concept of gene pools.
2. To investigate the relationship between gene frequencies in the gene pool and genotypes in a population.
3. To determine the relationship between gene frequencies in a population and phenotypes.