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a) i) Diploid cell has double the number of chromosomes of an haploid cell.

ii) Linkage refers to genes which are located on the same chromosomes.

iii) By conducting test crosses and examing the recombination frequencies of two particular genes, chromosome maps can be drawn. Recombination frequencies are calculated as the percentage of recombinations between genes. For example if two traits: height of plant and seat colour are examined and a heterozygous tall, green plant is crossed with a heterozygous tall green short yellow plant, the percentage of offspring who are tall yellow, short green is the recombination frequency. This is because, in meiosis, independent assortment occurs only if genes are located on different chromosomes. When on the same chromosome, crossing over is the only chance that a gamete from a tall green plant will contain Tall yellow alleles. In short, the further away genes are, the more likely crossing over will

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occurs, and thus the higher the recombination frequencies. Thus linkage can help in finding relative positions of genes on chromosomes.

b) i) Model of DNA was constructed using cardboard shapes to represent the four nitrogenous bases as well as the deoxyribose and the phosphate backbone. This model was much larger than actual DNA That is, an adenine was shaped to match with a cardboard thymine, and cytosine matched guanine These nitrogenous bases were in turn joined onto a hexagon (sugar) and then to a rectangle (phosphate) After cutting out the pieces and sticking them together in a ladder-like formation, the model was twisted around to mimic the helical nature of the DNA molecule.

ii) This model was designed to represent the relative positions of the sugar, base and phosphate.
ie it showed that a base is connected to a deoxyribose sugar which is connected to a phosphate group. This model also showed that

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the nitrogenous bases pair up according to their shape, and that adenine pairs up with thymine, and cytosine pairs with guanine. The size of the model (obviously much larger than actual DNA) allowed us to visualise the shape of the DNA molecule, in particular the double helix nature. However, this model did not show the hydrogen bonding which occurs between the bases or other such detail. (eg shape of the nitrogenous bases or phosphate group)

c) i)

ii) Polygenic inheritance refers to characteristics which are affected by more than one pair of genes.

iii) Polygenic inheritance of height in humans is completely different to the pattern of inheritance discovered by Gregor Mendel. Mendel's inheritance always had set ratios, with some alleles dominant over others. For example, height in pea plants could be predicted by the consideration of dominant & recessive alleles.

In polygenic inheritance there is no set ratio, but gradations as a result of the interaction of many different genes. Thus polygenic inheritance

produces a bell curve (seen by the graph) with fewer people extremely tall or extremely short due to the difficulty of inheriting all small genes or all tall genes etc.

Thus the polygenic inheritance of height in humans is different to Mendelian inheritance as polygenic traits are affected by more than one pair of genes, consequently phenotypes produced by the two types of inheritance vary differently as well.

d) Selective breeding is the agricultural practice of choosing organisms based on their traits & breeding them to produce desirable offspring. This has the effect of producing some organisms which are superior. If these organisms are constantly used to breed desirable offspring, then the long term effect is a decrease in genetic diversity. This is because the same genes will be passed on, and other genes may be eliminated or lost if they are comparatively undesirable. Consequently, the variation within a population will decrease, making the species

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susceptible to disease and extinction if conditions change. Because of the lack of genetic variability or mutations, natural selection may not occur & the population could be exterminated. Thus selective breeding may change the gene pool of a species.

Artificial insemination also constitutes somewhat of selective breeding as a sire is selected for its characteristics and the sperm injected into a female. For example, ~~in~~ cattle, semen is often bought from other parts of the world eg England, in order to inseminate a cow & produce superior offspring which may make more milk or produce more lean meat. Although at first this can be construed as an increase in genetic variability (genes from England may not otherwise be incorporated into Australian cattle gene pool), if this semen is used too often, or the resultant offspring bred too often, genetic diversity can decrease ~~in a similar way~~ because of the same genes being passed on from one generation to another.

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Gene cloning refers to the excision of a particular gene using restriction enzymes eg ECR1 to cut out the desirable gene from an organism. A ~~#~~ bacterial plasmid is also cut with the same restriction enzyme, forming similar sticky ends. The gene and plasmid are mixed together with DNA ligase, and then the gene becomes incorporated into the bacterial plasmid. This plasmid is then inserted into bacterial cell again which reproduces asexually producing more copies of the gene which can be harvested (cut out using restriction enzymes) or allowed to produce products eg ~~mouth~~ insulin. This process is very different to selective breeding but also has the potential to alter the genetic nature of a species. For example, if these genes are later used to produce transgenic organisms, both an increase & decrease in genetic diversity may occur. Via microinjection (Both of which use cloned genes) or agrobacterium, genes ~~from~~ from ~~a~~ an organism may be incorporated into another organisms DNA. The genes (which have been cloned) may have come

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from another species or even a different kingdom!
For instance, transgenic strawberries have been produced which contain a salmon gene which allows the strawberries to thrive in cold conditions.
Of course naturally this salmon gene would not have been transfered to Strawberry gene pool, but via gene cloning, the genetic diversity of strawberries has increased. Therefore by being able to incorporate all these genes from different sources into organisms, genetic diversity has the potential to increase dramatically.
As with selective breeding however, the overuse of a particular species (in this case the frost resistant strawberries) may lead to decreased genetic variation.
If these strawberries are continuously propagated (cloned) then there will be very little variation ~~in the~~ indeed, and there could be a mass extinction if conditions changed (similar to potato famine in Ireland) as no mutants could survive - lack of variation.
Therefore it can be seen that although the processes of selective breeding and gene cloning are different in many respects, such as final product (organism

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as opposed to genes), time required (selective breeding requires a lot of time, gene cloning can occur rapidly), etc, both have the capacity to change the genetic nature of species. This change may be an increase in diversity or a decrease which may put the species at risk of extinction.

2002 HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

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