1) Explain basic concepts of single gene inheritance using the terms *alleles, chromosomes, homozygous, heterozygous, dominant, recessive*.

Answer:
A good answer will include the following key points:
·Genes come in different forms called alleles.
·The alleles in a pair of chromosomes are sometimes the same, which makes them homozygous.
·The alleles in a pair of chromosomes sometimes differ, which makes them heterozygous.
·If a person is homozygous for a trait, such as eye colour, the genotype produces the phenotype.
·If a person is heterozygous for a trait, the phenotype produced depends on which allele is dominant.
·If one allele is dominant, its chemical instructions are followed whereas those of the other, the recessive allele, are ignored.

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Topic: Mechanisms of Heredity

Skill: Conceptual

2) Name and briefly describe some common disorders associated with recessive alleles.

Answer:
A good answer will include the following key points:
·Albinism: Skin lacks melanin, which causes visual problems and extreme sensitivity to light.
·Cystic fibrosis: Excess mucous clogs digestive and respiratory tracts.
·Phenylketonuria (PKU): Phenylalanine, an amino acid, accumulates in the body and damages the nervous system, causing mental retardation.
·Tay-Sachs disease: The nervous system degenerates in infancy, causing deafness, blindness, mental retardation, and, during the preschool years, death.

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Topic: Mechanisms of Heredity

Skill: Conceptual

3) Explain the general properties of the paths from genes to behaviour.

Answer:
A good answer will include the following key points:
·The behavioural consequences of genetic instructions depend on the environment in which those instructions develop.

Reaction range: The same genotype can produce a range of phenotypes, in reaction to the environment where development takes place.
·Heredity and environment interact dynamically throughout development.
·Genes can influence the kind of environment to which a child is exposed.
Niche-picking: The process of deliberately seeking environments that fit one's heredity.
·Environmental influences typically make children within a family different.
Nonshared environmental influences: The environmental forces that make siblings different from one another.

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Topic: Heredity, Environment, and Development

Skill: Conceptual

4) Your friends Shania and Ricky are expecting a baby. Both Shania and Ricky are farsighted and have cheek dimples. Shania and Ricky have said that they hope that their baby won't need to wear glasses or have cheek dimples because they both hate their glasses and dimples. What can you tell them about genetic inheritance and the likelihood that they will get their wish?

Answer:
A good answer will be similar to the following:
You can tell Shania and Ricky that both farsightedness and cheek dimples are dominant traits. That means that an individual who is heterozygous with one dominant allele and one recessive allele will still show the dominant trait. Given that both Shania and Ricky show the dominant traits, they both must have at least one allele for the dominant trait so the likelihood that their baby will NOT have the dominant traits of farsightedness and cheek dimples is small.

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Topic: Mechanisms of Heredity

Skill: Applied

5) Describe phenylketonuria. What is it, its causes, its symptoms, and treatment?

Answer:
A good answer will be similar to the following:
Phenylketonuria (PKU) is a disorder in which babies are born lacking an important enzyme. It is caused by two recessive alleles found on chromosome 12. The missing enzyme is one that breaks down phenylalanine, an amino acid. Without the enzyme, phenylalanine accumulates, damaging the nervous system and leading to delayed mental development. PKU can be controlled by diet by avoiding products that contain phenylalanine. With a special diet, mental retardation can be avoided.

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Topic: Mechanisms of Heredity

Skill: Factual

6) Name and describe (a) a disorder caused by an abnormal number of autosomal chromosomes, and (b) a disorder caused by an abnormal number of sex chromosomes.

Answer:
A good answer will include the following key points:
(a) Down syndrome is caused by an extra 21st chromosome.
°Symptoms:
·almond-shaped eyes
·a fold over the eyelid
·smaller than normal head, neck, and nose
·delayed mental and behavioural development
·mental retardation
(b) Klinefelter's syndrome (XXY chromosome pattern): Characteristics includes tall stature, small testicles, sterile, below-normal intelligence, passive. Males only. OR
·XYY complement: Characteristics include tall stature and, sometimes, below-normal intelligence. Males only. OR
·Turner's syndrome (Xo): Characteristics are short stature, limited development of secondary sex characteristics, problems perceiving spatial relations. Females only. OR
·XXX syndrome: Characteristics are normal stature but delayed motor and language development. Females only.

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Topic: Mechanisms of Heredity

Skill: Factual

7) Explain how (a) twin studies and (b) adoption studies are used to determine the influence of heredity on a trait and discuss a potential flaw of each type of study.

Answer:
A good answer will be similar to the following:
(a) *Twin studies* compare identical and fraternal twins to determine the influence of heredity. Identical or monozygotic twins come from a single fertilized egg that splits in two, and they have the same genes. Fraternal or dizygotic twins come from two separate eggs fertilized by two separate sperm and share, on average, about half their genes just like regular siblings. In a twin study, if identical twins are more alike than fraternal twins on a particular trait or behaviour, it suggests that heredity influences that trait or behaviour. *Potential flaw:* Parents and other people may treat identical twins more similarly than they treat fraternal twins. This would make identical twins more similar

than fraternal twins in their experiences as well as in their genes.
(b) In *adoption studies*, adopted children are compared to their adoptive parents and their biological parents. Adoptive parents have provided the child's environment. Biological parents provided the child's genes. If children are more similar to their biological parents than to their adoptive parents on a particular trait or behaviour, it suggests that genes influence that trait or behaviour. *Potential flaw*: Adoption agencies may try to place children in homes like those of their biological parents. This can bias adoption studies because biological and adoptive parents end up being similar.

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Topic: Heredity, Environment, and Development

Skill: Conceptual

8) Explain what is meant by a reaction range and give an example of how a reaction range might work.

Answer:
A good answer will include the following key points:
Reaction range: The same genotype can produce a range of phenotypes, in reaction to the environment where development takes place.
For example, individuals with the genotype for phenylketonuria (PKU) lack an enzyme that breaks down the amino acid, phenylalanine, which is found in many foods that children regularly eat. If phenylalanine is ingested, it will accumulate in the child's body, damage the nervous system and lead to delayed mental development. If, though, the child is placed on a diet that limits phenyl- alanine, the disease does not emerge and the nervous system develops normally.

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Topic: Heredity, Environment, and Development

Skill: Conceptual

9) You and a friend were talking about the role of heredity and environment and your friend said, "Heredity is destiny. When someone inherits genes for bad diseases there is nothing about the environment that can change the negative effects." What can you tell your friend about the interaction of heredity and environment in cases such as those involving individuals with phenylketonuria?

Answer:
A good answer will be similar to the following:
You can tell your friend that heredity is not destiny. One can inherit a particular genotype but that genotype can interact with a particular environment to change the phenotype. In the case of phenylketonuria (PKU), an individual may inherit the gene for PKU.

Typically, the individual lacks an enzyme that breaks down phenylalanine. Phenylalanine is found in many foods such as meats and dairy products. When the phenylalanine is not broken down it builds up and produces toxins that damage the nervous system, which leads to mental retardation. However, if the environment is changed so that the amount of phenylalanine in a child's diet is reduced, then the damage to the nervous system does not occur and normal intelligence occurs. In other words, the same genotype for PKU can interact with two different environments (either a regular diet or a low-phenylalanine diet) to lead to two very different outcomes (either normal intelligence or mental retardation). So, even in the case of a negative, inherited disorder the environment can still play an important role in shaping the environment.

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Topic: Heredity, Environment, and Development

Skill: Conceptual

10) The other day I heard someone say "There is no such thing as twins who are brother/sisters (mix-sex twins)." What would you have said if you had been there?

Answer:
You could have told him/her that he/she was thinking about monozygotic twins. These twins are the result of one fertilized egg that has divided. Therefore monozygotic (or identical) twins have the exact same genes—so they must also be the same sex. However, dizygotic twins come from two separate eggs fertilized by two separate sperm. These twins have the same genetic overlap as full brothers and sisters, but just as you can have a boy and a girl in the same family, you can also have mix-sex dizygotic (fraternal) twins.

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11) Why are African Canadians more likely to inherit sickle-cell disease?

Answer:
African Canadians are more likely to inherit sickle-cell disease because the sickle cell has a benefit: Individuals with this allele are more resistant to malaria. Therefore, in parts of the world (such as Africa) where malaria is found you are also more likely to find individuals carrying this trait. Having two alleles for sickle-cell disease has devastating consequences to the carrier. However, having only one sickle cell allele results in a person who is more resistant to malaria and yet suffers from the disorder only when put under extreme conditions (in instances of low oxygen). Therefore, having sickle-cell trait is quite adaptive in Africa. However, it has no adaptive value in Canada and accordingly we are seeing fewer and fewer individuals with sickle-cell trait in successive generations of African Canadians.

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Skill: Conceptual