Total of 7 questions, 100 points.

QUESTION 1. Circle the correct answer. Total of 40 points – 4 points each.

1. Which of the following is typically attacked by the antibody-mediated response, and not the cell-mediated response?
   A) bacterial cells
   B) protozoa
   C) cancer cells
   D) fungal cells
   E) virus-infected cells

2. Why is it easy to measure allele frequencies in a codominant allele system?
   A) Phenotypes are equivalent to genotypes
   B) Most alleles are present in a homozygous condition
   C) They are present in a 3:1 ratio in all populations
   D) Such systems are rare

3. DNA fragments run on a gel separate based on
   A) Charge of the DNA fragment
   B) Size of the DNA fragment
   C) The shape of the DNA fragment
   D) Both A and C
   E) Both A and B

4. In the immune response, which cell type functions as an ‘ON’ switch for antibody production?
   A) macrophages
   B) neutrophils
   C) Killer T cells
   D) Helper T cells
   E) B cells

5. Microarray expressing profiling experiments give you information about
   A) All the DNA sequences present in the cell
   B) All the mRNAs present in the cell
   C) All the mutations present in the genome of the cell
   D) Both A and B

6. Nuclear transfer
   A) Uses an unfertilized egg as the starting point
   B) Requires that the recipient cell be enucleated
   C) Mimics the way identical twins are produced naturally
D) Does not require the use of a host uterus

7. Linked genes
   A) Can assort independently
   B) Are always present on the X chromosome
   C) Can never separate
   D) Are present on the same chromosome

8. Intracytoplasmic sperm injection to produce a biological child can be used by couples in which:
   A) The female cannot implant an embryo
   B) The male cannot produce sperm
   C) The male’s sperm are immotile
   D) The female’s eggs cannot be harvested

9. In ex vivo gene therapy methods:
   A) Recombinant retroviruses directly infect the affected tissue
   B) Viruses carrying the DNA are used to infect cells in culture first
   C) Embryonic stem cells are transplanted into the patient
   D) Viruses are used to infect somatic cells

10. Primers in PCR reactions:
    A) Hybridize to only one DNA strand
    B) Elongate the DNA strands
    C) Hybridize to both DNA strands and make complementary copies
    D) Are amplified exponentially

**QUESTION 2. Short answers. Total of 14 points.**

1. What are TWO differences between adult and embryonic stem cells? 4 points

   Collected from embryos vs adults; Potential can be restricted; Present in smaller numbers..

2. Name TWO assumptions of the Hardy-Weinberg Law. 4 points

   Large population; no selection; random mating; no mutations or migrations

3. What are THREE key properties of a cloning vector? 6 points

   Many sites for insertion; selection; capable of hosting foreign DNA; capable of independent replication...
**QUESTION 3. Definitions. 2 points each – total of 20 points**

1. Gene pool
   Collection of all alleles in a population

2. Map unit
   Recombination frequency of 1% between two genes

3. Restriction enzyme
   Enzyme that cuts dsDNA at specific sites

4. A reporter gene
   Gene that can be used to follow where another gene is expressed

5. Neurotransmitter
   Molecule that transmits electrical information across a synapse

6. Linkage analysis (eg for behaviors)
   Analysis to show that particular regions co-segregate with the behavior

7. Microsatellites
   Repeats of short DNA sequences that vary from individual to individual

8. Shotgun cloning
   Random cloning of DNA fragments

9. DNA profile
   The pattern of repeats in a given individual

10. Synteny
    Conservation of feature order across genomes

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**QUESTION 4. 8 points**

Eye-rolling is an autosomal recessive trait that is closely linked to an STR (short tandem repeat) pattern follow on a gel. Shown is the pedigree of an affected family.
1. Is Daughter II.4 likely to be a carrier of the eye-rolling trait? **2 points**

No.

2. Of the children who are carriers, did they inherit the mutated allele from their mother or father? Use the numbers to indicate the carrier (eg. II.1, II.2 etc). **6 points**

II.3 – from mother
II.5 – from father

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**Question 5.** **10 points**

1. Suppose that an infectious agent such as a virus or bacteria had surface antigens identical to those displayed on the surface of human cells. Would the immune system be able to detect and destroy these agents? Why or why not? **4 points**

No. Would not recognize them as non-self due to T-cell selection in thymus.

2. You have identified the YFG gene (Your Favorite Gene) from a mouse and want to see in which tissue this gene is expressed. Name and briefly describe the steps in ONE technique by which you could determine this. *(Describe the major steps: for example, PCR followed by cloning into vectors etc and not method details like place paper towels on gel, or the details of the PCR reaction)* **6 points**

Several possibilities:
- Extract tissue, run Northern blot and probe with gene
- Do PCR from different tissues
- Make a reporter gene fusion and make transgenic mouse to see where gene is on
**QUESTION 7. Total of 8 points**

1. In some association studies of depression and bipolar disorders, correlations to specific alleles are only obvious when participants are divided into subgroups based on symptoms. What do you think could be the biological basis for this? *4 points*

   Symptoms define subgroups of the disease which are correlated with specific genes

2. Now that you know a whole lot about genetics and heredity, next time you read an article stating that the gene underlying a particular human behavior has been identified, what are the red flags that you will be looking for in these studies? *4 points*

   Look at sample size, look at how the behavior was defined, look at pedigrees to see how good the linkage/association is..

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**TOTAL**