This exam consists of 40 multiple choice questions worth 2.5 points each, for a total of 100 points. Good luck.

1. The graph below shows regression lines derived from plotting midparent height values versus mean offspring height values for two populations of corn. Based on this data, which of the following statements is true?

   Answer: c

   ![Graph showing regression lines]

   a) The value of $h^2$ for population B is higher than that for population A.
   b) Environmental variance influences the height of population A more than population B.
   c) It will be easier to change the height of population A by selective breeding.
   d) The proportion of phenotypic variance due to additive genetic variance is higher for population B.
   e) The value of $H^2$ for population A is higher than that for population B.

2. The norm of reaction:

   Answer: a

   a) Converts a distribution of environments into a distribution of phenotypes.
   b) Is the portion of phenotypic variance due to environmental variance.
   c) Is the central tendency of the phenotype for a given genotype.
   d) Converts a distribution of environments into a distribution of genotypes.
   e) Converts the distribution of genotypes into a distribution of phenotypes.

3. Broad heritability is defined as:

   Answer: e

   a) The part of total phenotypic inheritance due to environmental variance.
   b) The part of total phenotypic inheritance due to dominance genetic variance.
   c) The part of total phenotypic inheritance due to additive genetic variance.
   d) The part of total phenotypic inheritance due to maternal genetic variance.
   e) The part of total phenotypic inheritance due to total genetic variance.
4. In nature, phenotypic variability is essentially continuous because of all the reasons listed below except:
   a) Each genotype does not produce a single phenotype. Answer: b
   b) There is little phenotypic overlap between different genotypes.
   c) Many genes contribute to a given phenotype.
   d) Environmental variability affects phenotype.

5. A population may not be in Hardy-Weinberg equilibrium because:
   Answer: e
   a) Individuals having different genotypes may immigrate.
   b) Some genotypes may prefer to mate with another genotype.
   c) A new mutant may generate more progeny.
   d) A new combination of alleles may extend lifespan.
   e) All of the above.

Questions 6-8 concern the three populations listed below.

<table>
<thead>
<tr>
<th></th>
<th>fR/R</th>
<th>fR/r</th>
<th>fr/r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population I</td>
<td>0.3</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Population II</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Population III</td>
<td>0.0</td>
<td>0.8</td>
<td>0.2</td>
</tr>
</tbody>
</table>

6. What is the frequency of R in each population? Answer: a
   a) 0.4   b) 0.3   c) 0.6   d) 0.2   e) 0.8

7. What is the frequency of R/r when these populations are in Hardy-Weinberg equilibrium? Answer: d
   a) 0.16  b) 0.24  c) 0.36  d) 0.48  e) 0.72

8. Which population is closest to being in Hardy-Weinberg equilibrium? Answer: b
   a) I   b) II   c) III

9. The D locus has only two alleles, D and d. What is the frequency of the d allele in the following population. Answer: d
   105 D/D
   210 D/d
   185 d/d
   a) 42%   b) 21%   c) 24%   d) 58%   e) 79%

10. Which of the following will increase genetic variation? Answer: a
    a) Decreased population size
    b) Decreased migration
    c) Random mating
    d) Increased repair of mutations
    e) Equivalent reproduction and survival rates among genotypes

11. A mutation having reduced function is referred to as a: Answer: d
    a) Null mutant
    b) Hypermorphic mutant
    c) Neomorphic mutant
    d) Hypomorphic mutant
    e) Conditional mutant
12. RISC mediates all of the following aspects of RNA interference EXCEPT: Answer: b
a) Binding dsRNA
b) Chopping up dsRNA
c) Degrading mRNA
d) Unwinding dsRNA
e) Binding mRNA complementary to unwound dsRNA

13. Which of the following is an example of a genetic selection? Answer: c
a) Isolating genes having a particular expression pattern.
b) Isolating mutants that affect eye development.
c) Isolating mutants that are resistant to insecticide.
d) Isolating mutants that have sleep abnormalities.
e) Isolating genes having altered pigmentation patterns.

14. Which of the following statements is associated with reverse genetic analysis? Answer: a
a) Making a null mutant in a particular gene to determine its phenotype.
b) Complementation analysis of mutants having a common phenotype.
c) Identifying all genes that produce a certain phenotype.
d) Mutagenizing wild type with a general mutagen such as EMS.
e) Isolating all genes having a particular expression pattern.

15. Crossing-over within a pericentric inversion loop generates: Answer: c
a) Two ‘normal’ products (one inverted & one in correct order), a dicentric bridge and an acentric fragment
b) Two ‘normal’ products (both in correct order), a dicentric bridge and an acentric fragment
c) Two ‘normal’ products (one inverted & one in correct order) and two abnormal products (both contain a duplication & a deletion).
d) Two ‘normal’ products (one inverted & one in correct order) and two abnormal products (both are duplications).
e) Two ‘normal’ products (both in correct order) and two abnormal products (both contain a duplication & a deletion).

16. In the pairing configuration of the reciprocal translocation below, which chromosomes would segregate into the same gametes by alternate segregation? Answer: c

\[ N1 \quad O \quad T1 \quad O \quad O \quad T2 \quad N2 \]

a) N1+T2 & T1+N2  b) N1+T1 & T2+N2  c) N1+N2 & T1+T2

17. Which of the following is a monosomic condition in humans? Answer: d
a) Down syndrome  b) Williams syndrome  c) cri du chat syndrome
d) Turners syndrome  e) Klinefelters syndrome

18. Nondisjunction during meiosis results in: Answer: c
a) Autotriplody  b) Autopolyploidy  c) Aneuploidy  d) Allopolyplody  e) Monopolody

19. Which of the following would generate the largest grapes? Answer: e
a) A trisomic  b) An autotriploid  c) An autotetraploid  d) A diploid  e) An autooctaploid
20. An fertile hybrid generated by crossing a cabbage and a radish is called an __________________.
   a) Allopolyploid   b) Monosomic   c) Autotetraploid   d) Trisomic   e) Aneuploid
   Answer: a

21. Which of the following can not produce viable gametes? (assume 2n = 20)
   a) Autotetraploids   b) Triploids   c) Trisomics   d) Allotetraploids   e) Diploids
   Answer: b

22. Meiotic recombination is initiated by:
   a) Single strand breaks
   b) Strand invasion
   c) Double strand breaks
   d) Heteroduplex formation
   e) Mismatch repair
   Answer: c

23. DNA glycosylases function in which DNA repair system?
   a) Base excision repair
   b) Mismatch repair
   c) Double strand break repair
   d) Nucleotide excision repair
   e) Direct reversal of pyrimidine dimers
   Answer: a

24. In the Luria and Delbrück fluctuation test, large variations in the number of bacteria resistant to T1 phage infection from different independently grown cultures led to the following conclusion:
   a) T1 phage induced mutations at different rates.
   b) Mutations occurred randomly in the population before T1 phage were added.
   c) Cells grown with T1 phage were more susceptible to mutation.
   d) Not all E. coli can be induced to be resistant to T1 phage infection.
   e) Some cultures of E. coli are not fast enough to avoid T1 phage infection.
   Answer: b

25. An alkylated guanine will base pair with:
   a) adenine   b) cytosine   c) guanine   d) thymine   e) uracil
   Answer: d

26. Intercalating agents always cause _______________ mutations?
   a) transition   b) frameshift   c) insertion/deletion   d) transversion   e) base substitutions
   Answer: c

27. What is the only type of mutation that can arise from mispairing due to tautomeric shifts?
   a) recessive   b) missense   c) transversion   d) transition   e) frameshift
   Answer: d

28. A mutation that causes a lysine to be replaced with an arginine is called a ________________ mutation.
   a) nonsense   b) missense   c) transition   d) synonymous   e) transversion
   Answer: b

29. Which of the following represents a transversion mutation?
   a) G·C → T·A   b) A·T → G·C   c) C·G → T·A   d) T·A → C·G
   Answer: a

30. Alu sequences are nonautonomous _______________ that comprise 10% of the human genome.
   a) transposons   b) SINEs   c) P-elements   d) LINEs   e) Ac elements
   Answer: b

31. Which of the statements below best describe what will happen when a female Drosophila with a P cytotype is crossed to a male Drosophila with an M cytotype?
   a) P elements will be mobilized in the F₁ progeny
   b) There will be no F₂ progeny if the F₁ is selfed
   c) The F₁ progeny will be dysgenic
   d) The F₁ progeny will all be M cytotype
   e) Normal numbers of F₂ progeny will result if the F₁ is selfed
   Answer: e
32. During transposition, retrotransposons use reverse transcriptase to:  
   a) Synthesize retrotransposon RNA from retrotransposons in the chromosome.  
   b) Insert retrotransposon DNA into a chromosome.  
   c) Degrade excess copies of retrotransposon RNA.  
   d) Synthesize DNA copies of retrotransposon RNA.  
   e) Synthesize RNA copies of retrotransposon RNA.  
   Answer: d

33. Bacterial IS elements always generate __________ repeats at their site of insertion.  
   a) inverted  
   b) 14bp  
   c) direct  
   d) no  
   e) 5bp  
   Answer: c

34. Which of the following best describes an Ac transposable element?  
   a) A non-autonomous retrotransposon in corn.  
   b) An autonomous retrotransposon in Drosophila.  
   c) An autonomous transposon in corn.  
   d) A non-autonomous transposon in corn.  
   e) An autonomous retrotransposon in corn.  
   Answer: c

35. You have generated a tk⁺ targeting vector containing a mouse gene that was inactivated by inserting a neomycin resistance gene into the protein coding region. To select for a recombinant mouse ES cell in which the disrupted gene has replaced the normal gene, you select for cells that are:  
   a) neo⁺ tk⁻  
   b) neo⁺ tk⁺  
   c) neo⁻ tk⁻  
   d) neo⁻ tk⁺  
   Answer: a

36. Which of the following statements about transgenic plants is true?  
   a) The Ti plasmid only inserts at one place in the plant chromosomal DNA  
   b) All transgenic plants have crown galls.  
   c) T-DNA is transferred to plant cells upon infection with Agrobacterium tumefaciens.  
   d) Transgenic plants require nopaline for their survival.  
   e) The Ti plasmids in transgenic plants must have an origin of replication to replicate.  
   Answer: c

37. Which choice best describes the sequence of events in one round of polymerase chain reaction (PCR)?  
   a) First incubate at 95°C to denature double strand DNA, then incubate at 72°C to polymerize a new DNA strand, then incubate at 55°C to hybridize the primers to the template.  
   b) First incubate at 95°C to denature double strand DNA, then incubate at 55°C to hybridize the primers to the template, then incubate at 72°C to polymerize a new DNA strand.  
   c) First incubate at 72°C to denature double strand DNA, then incubate at 95°C to hybridize the primers to the template, then incubate at 55°C to polymerize a new DNA strand.  
   d) First incubate at 95°C to denature double strand DNA, then incubate at 72°C to hybridize the primers to the template, then incubate at 55°C to polymerize a new DNA strand.  
   e) First incubate at 55°C to hybridize the primers to the template, then incubate at 95°C to denature double strand DNA, then incubate at 72°C to polymerize a new DNA strand.  
   Answer: b

38. How are dideoxynucleotides modified so that they terminate DNA synthesis?  
   a) They have a 3' hydrogen instead of a 3' hydroxyl  
   b) They lack the base  
   c) They have a 3' phosphate instead of a 3' hydroxyl  
   d) They have a 5' hydroxyl instead of a 5' phosphate  
   e) They have a 2' hydrogen instead of a 2' hydroxyl  
   Answer: a

39. Which is the best estimate for the minimum number of BACs it would take to clone a 2 million base pair genome?  
   a) 14  
   b) 500  
   c) 2  
   d) 100  
   e) 40  
   Answer: a
40. Assuming that genomic DNA sequence is random (i.e. that every nucleotide is equally likely to have A, C, G, or T), how often would a restriction enzyme cut DNA on average if it had a 6bp target sequence?

   a) every 256bp   b) every 1024bp   c) every 24bp   d) every 4096bp   e) every 1296bp   Answer: d