**FINAL EXAM 2021.**

1. **Calculus**: A = 0.6, a = 0.4, B = 0.7, b = 0.3. Probability of Ab? Ab = A*b = 0.6*0.3.

2. **True**: There are significant differences in nucleotide diversity between regions within a gene.

3. **Calculus**: Formula 0.5475: $2pq / p^2 + 2pq$. Heterozygous part respects positive Rh.

4. **What is a panmictic population?** Random mating population.

5. **Which is higher?** Heterozygosity is much higher in microsatellites than allozyme variation.

6. A method of genotype-phenotype test: 2x2 contingency table chi-square.

7. **Average time of fixation in a finite size population?** Time fixation >> Time loss.

8. **Under the general model of selection, which statement is not correct?** Favorable alleles will not always get fixed.

9. **In natural populations**, Ne/N < 1.

10. **Probability that a new neutral mutation will get fixed in infinite size**: 0.

11. **Rate for adaptive evolution** is higher in large populations.

12. **If we pool two or more populations in HW equilibrium, the Wahlund effect** will pool populations that show a deficit of heterogeneity (excess homozygosity and deficit heterozygotes).

13. **Tajima's D test compares** two estimators of heterozygosity from a single gene.

14. **The HKA test determines** whether there are relationships between polymorphism and divergence across two or more genes.

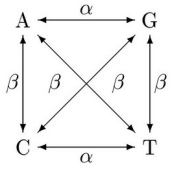
15. **The MK test compares** the number of synonymous and nonsynonymous substitutions from one gene.

16. **Which statement is true about molecular clocks?** After observing a given protein, the evolutionary rate is constant.

17. **Which is true regarding the hypothesis of the molecular clock?** The higher the functional constraint the lower the substitution rate.

18. **The k parameter of Jukes and Cantor model**: range from 0 to infinity. K indicates the number of substitutions (mutations) and p is the proportion of changes. P goes from 0 to 1. When we cannot correct the K from p is from 0 to 0.75.

19. **The probability of changing from C to T** is the same from A to G.



20. **The comparison of the DNA sequences between alpha and beta kimurine of a primate gives an estimate of k = 0.5, that** these sequences likely differ by less than 500 differences. If k = 0.5, means that there is 50% of probability that the positions are different. The real changes of k = 0.5 will be 500 changes and differences will be less than 500. If k = 0.6, there will be 600 mutations

21. **PAM matrices…** the values of the matrix are proportional to the probability of change of one amino acid to another.

22. **Calculus**: 8 differences and length (800 bp) and $10^{-9}$ years. p = r = 8 / 800 = 0.01. Then 0.01 = k / 2T.

23. **Which statement is false regarding the HKA test in the software DnaSp**: The test can be applied to data from a single species.

24. **Which statement is false?** The number of unrooted trees will depend on the phylogenetic reconstruction method.

25. **Which statement is true regarding the monophyletic definition?** All taxa within the group derive from a single common ancestor, so there are no members from other groups. Paraphyletic: the group contains some, but not all, of the descendants from a common ancestor common; members do not form a natural clade.

26. **After analyzing an alignment of DNA sequences with MEGA we obtain the substitution rate from T to C is 0.470 whereas the substitution rate from C to T is 0…. In addition each nucleotide base of our alignment occurs in a sequence of 25%. Which nucleotide substitution model will be the best?** The Hasegawa kishino yano.

27. **After applying the MK test for mammalian species in a DnaSp software, we obtain a value of 0.015. Can we infer the action of positive selection from this result?** It will depend on the value and sign of the neutrality index (NI).

28. **In a codon substitution model, in which changes the probability is equal to omega (dN/ dS)?** Nonsynonymous changes that are also transversions.

29. **We estimated the parameter omega without considering that there is strong transition/transversion bias in our sequences, our estimated value of omega is 0.89.** The actual omega value is probably higher than 0.89.

**Values:**
- **D’ and $p^2$ between 0 and 1.**
- **K parameter between 0 and infinity.**
- **H is between 0 and 1.**
- **Allelic frequency (p) from 0 to 1.**
- **Selection coefficient (s) from 0 to 1. The value 1 is lethal.**
- **Fst between 0 and 1.**

**<u>MIDTERM 2022</u>**

1. In a cow farm, there are cows with different skin colors: 260 are white, 1430 are red, and 1130 have both colors. Considering that hair color is determined by a single gene with two alleles, which of the following is FALSE?

**a) The frequency of the white color allele is 0.092**
b) The frequency of the red color allele is 0.707
c) The frequency of homozygotes for the red allele is 0.507
d) The frequency of heterozygotes in the population is 0.401

2. The frequency of a recssive disease caused by an allele in a gene located in chromosome X and found with frequency q in a given population:
a) Will be lower in females, who will present the disease with a frequency $q^2$
b) Will be higher in males, who will present the disease with a frequency q
c) Will be the same in both sexes
**d) Answers a and b are true**

3. Which of the following is FALSE?
a) SNPs, indels and inversions are mostly variants with two alleles
**b) Variants located outside of coding regions cannot affect phenotype**
c) CNVs can have multiple alleles with different number of copies of a gene
d) Variants with alleles with frequencies higher than 1% are considered polymorphic

4. Which of the following is FALSE?
a) When directional selection and genetic drift act at the same time, drift can prevent the advantageous allele from being fixed
b) The smaller the population, the fastest the fixation of an allele due to genetic drift will occur
c) The larger the difference in fitness of two alleles, the faster the fixation due to natural selection will occur
**d) The more similar the initial frequencies of two alleles, the fastest the fixation of an allele due to genetic drift will occur**

5. An archipelago of a thousand islands in the Adriatic Sea is colonized by species of bird in which a locus has two alleles with frequencies p = q = 0.5. Each island is occupied by a couple and the population size remains small for the following generations. What would you expect to find if these populations were analyzed after a thousand years? Assume that the populations are in Hardy-Weinberg equilibrium and that there is no migration between islands.
a) All populations would present the same frequency p = 1
b) All populations would present the same frequency p = 0.5
**c) 50% of the populations would present frequency p = 1 and 50% would present frequency p = 0**
d) All populations would present the same frequency p = 0

6. White fur color is determined in mink by a recessive autosomic allele. In a large population with random mating, white individuals represent 36% of the population. However, illegal hunters capture 20% of white mink every generation. Which will be the frequency of white mink in the current generation after one round of selection takes place?
a) 0.36
b) 0.6
c) 0.431
**d) 0.569**

7. The fitness values for the genotypes AA, Aa, and aa in a population are 0.8, 1 and 0.4, respectively. This population is evolving by:
a) Directional selection against dominant allele A

b) Selection against the heterozygote
c) Directional selection against recessive allele a
**d) Balancing selection favoring the heterozygote**

8. Which of the following statements regarding genetic drift is FALSE?
a) The effective size of a population ($N_e$) can be smaller than the census size (N) due to different number of males and females or to fluctuations in population size
b) The probability of fixation of an allele is equal to its initial frequency
**c) New alleles appearing by mutation in a population are more likely to get fixed than lost because their initial frequency is 1/2N**
d) Bottlenecks cause a long-term reduction of the genetic variation in a population that can persist even after population regains previous size

9. In a certain African population, 4% of the population is born with sickle cell anemia (ss). Calculate the percentage of individuals who enjoy the selective advantage of the sickle-cell allele (increased resistance to malaria).
**a) 32%**
b) Can't tell from the information given
c) 64%
d) 4%

10. Indicate if the following sentences are true or false: (1) Allele frequencies can differ among subpopulations due to effects of genetic drift or local adaptation. (2) A high $F_{ST}$ indicates a low level of differentiation among subpopulations.
a) 1 false and 2 true
b) Both true
**c) 1 true and 2 false**
d) Both false

**1. Ayala et al. (1975) analyzed allozyme variability in the krill (Euphasia superba). Here are the results for two loci.**

| | Allele | | | | | | Observed |
|---|---|---|---|---|---|---|---|
| Locus | 96 | 98 | 100 | 102 | 106 | 110 | Heterozygosity |
| Acp-1 | | | 0,996 | | | 0,004 | 0,008 |
| Ao-1 | | 0,012 | 0,960 | 0,028 | | | 0,081 |

**Which of the two loci is polymorphic (under the 99% criterion)?**
(a) Acp-1 **(b) Ao-1** (c) Both (d) None

**2. Nucleotide diversity (π) estimates in humans are around**
(a) 0.1 (b) 0.01 **(c) 0.001** (d) 0.0001

**3. Which of the following characteristics of microsatellites is NOT correct?**
(a) Microsatellite alleles often have codominant inheritance
(b) Can be used for identification of individuals and paternity testing
**(c) They are distributed in the genome very unevenly, being more abundant near the telomeres and the centromere.**
(d) They can be analyzed by non-invasive sampling.

**4. Please indicate which of the following statements is true.**
**(1) All members of the human species have the same number of protein-coding genes.**
**(2) The nucleotide diversity of humans is greater in Africa than in Europe.**
(a) Both true (c) 1 true and 2 false (b) Both false **(d) 1 false and 2 true**

**5. Consider is a locus with two alleles, A and a, at frequencies p and q, respectively. In a random-mating population, what proportion of heterozygous offspring will a heterozygous individual leave behind?**
(a) p (b) q (c) 1/4 **(d) ½**

**6. In the human Rhesus blood group, allele D (Rh+) is dominant over allele d (Rh-). In Turkey, the frequency of individuals with negative Rh is 14% (Dilek et al. 2006). What is the expected proportion of carriers (heterozygous Dd) among the individuals with positive Rh?**
(a) 86% **(b) 54%** (c) 47% (d) 27%

**7. What is the range of values for D' (relative linkage disequilibrium)?**
**(a) $0 \leq D \leq 1$** (b) $-1 \leq D \leq 1$ (c) $0 \leq D \leq \infty$ (d) $-\infty \leq D \leq \infty$

**8. In a discovery GWAS in humans for the phenotype "risk tolerance", we have detected a statistically significant effect of a given SNP. What is the meaning of this result?**
(a)This SNP is causally responsible for this phenotype
(b)This SNP is located within a gene responsible for this phenotype
**(c) This SNP is located near a gene responsible for this phenotype**
(d) This SNP has nothing to do with this phenotype

**9. In a population of size N = 10 individuals, if in one generation the allele frequencies are p = q = 0.5, what is the probability that in the next generation the frequencies will remain the same?**
(a) 1 (b) 0.5 (c) 0.25 **(d) 0.18**

**10. If we sequence a random sample of 10 alleles from a neutrally-evolving locus in humans, what is the expected coalescence time of all the alleles into a single one?**

a)10,000 generations (c) 100,000 generations

**(b)36,000 generations** (d) 360,000 generations

**11. Consider two cattle farms in Texas. In Santa Rosa Ranch there are 120 cows and 3 bulls whereas in Falster Farm there are 40 cows and 4 bulls. Which one has a larger effective population size?**

(a) Santa Rosa Ranch (c) Both have the same Ne

**(b) Falster Farm** (d) You can't know

**12. The average time between two consecutive neutral substitutions is**

(a) 4Ne generations (c) 2(Ne/N) ln 2N generations

**(b) 1/μ generations** (d) 4Ne μ generations

**13. Which one of the fitness sets for the three genotypes in a diallelic locus, will not give rise to the same gene frequency changes as the others?**

(a) 4, 3, 2 **(b) 3, 2, 1** (c) 2, 1.5, 1 (d) 1, 0.75, 0.5

**14. In one study in West Africa, the fitness of the three genotypes AA, AS and SS for the hemoglobin gene was estimated as 0.9246, 1 and 0.2447. What is the mean fitness of the population at equilibrium?**

(a) 0.7231 (b) 0.9246 **(c) 0.9314** (d) 1

**15. Please indicate which of the following statements is true. (1) Expected rate of adaptive evolution increases with population size. (2) Nearly neutral theory of molecular evolution proposes that a great part of the mutations fixed in evolution are slightly deleterious.**

**(a) Both true** (c) 1 true and 2 false (b) Both false (d) 1 false and 2 true

**16. Hibiscus aridicola is an endangered ornamental plant found in dry-hot valleys of the Jinsha River (China). Zhang et al. (2019) analyzed 11 microsatellite loci in 69 individuals from four populations and observed the following mean expected heterozygosities.**

| Population | Heterozygosity |
|---|---|
| Labo Town | 0.7528 |
| Muxintu Village | 0.7066 |
| Jinyang County | 0.6999 |
| Xiazhien Village | 0.6962 |
| Total | 0.7894 |

**Estimate the rate of migration (Nm) assuming genetic drift-migration equilibrium.**

(a) 0.03 (b) 0.10 (c) 0.62 **(d) 2.36**

**17. Two populations, A and B, have frequencies of a given allele 0.35 and 0.72, respectively. Assuming migration m = 0.10 from B to A and m = 0.05 from A to B, which one of the two populations change faster in allele frequency?**

**(a) A** (b) B (c) both equal (d) You can't know

**18. Which of the following is FALSE?**

(a)The smaller the population, the fastest the fixation of an allele due to genetic drift will occur.

**(b)The more similar the initial frequencies of two alleles, the fastest the fixation of an allele due to genetic drift will occur.**

(c) The larger the difference in biological efficiencies of two alleles, the faster the fixation due to natural selection will occur.

(d)When directional selection and genetic drift act at the same time, the drift prevents the advantageous allele from always being fixed.

**19. Consider the case of natural selection acting in favor of the heterozygote, in the presence of genetic drift. Which one is TRUE:**

(a)If the drift is very strong (small N) one of the two alleles (always the advantageous one) will be fixed.

(b)If the drift is very strong (small N) one of the two alleles (always the one with the highest frequency) will be fixed.

**(c) If the drift is very strong (small N) one of the two alleles (the advantageous or the one with the highest frequency) will be fixed.**

(d) Even if the drift is very strong (small N) none of the two alleles will be fixed.

**20. To computationally simulate the genetic drift, which one is FALSE:**

(a)We use a linear random walk using the random binomial distribution function. The binomial distribution describes the sampling process of genetic drift.

(b)We use a linear random walk using the sample() function to simulate the random sampling of alleles in a population.

(c) The binomial formula describes the probability distribution of i successes in N trails, where the probability of success is p: similar to sampling alleles from a population.

**(d)The random walk function just needs the initial allele frequency of allele A (p_0) and the number of generations to be simulated (tgen).**