

Plant Genetics PBG430/530
Exam 3, 2013

You spend several hours at NCBI nucleotide using BLAST to identify similarities and differences between storage proteins in wheat and barley. Your long-term goal is to breed varieties of both crops that will be lower elicitors of "gluten intolerance". You find a complete genomic sequence for one protein in barley and for one protein in each of the three genomes of wheat.

1. When you BLAST each of the three wheat protein nucleotide sequences against the barley sequence you find E values ranging from $6e-171$ to $2e-156$ and Max identities from 81 – 87%. This means the wheat and barley sequences are
 - a. Identical
 - b. Quite similar
 - c. Very different
 - d. Completely different
2. The cds for each of the A,B, D, and H genome sequences is the same as the corresponding sequence between the start and stop codons. This means that
 - a. There is epigenetic silencing
 - b. The mRNAs have been cleaved by RNAi
 - c. The genes encoding the proteins have introns
 - d. The genes encoding the proteins do not have introns
3. If the cds for the wheat genome is 636 nucleotides long (**not** including the stop codon), how many amino acids are there in the polypeptide?
 - a. 212
 - b. 424
 - c. 636
 - d. 2,544
4. What do you predict will be the first amino acid in the H genome polypeptide sequence?
 - a. Adenosine
 - b. Tyrosine
 - c. Methionine
 - d. Glutamine
5. Where would you expect to find the most DNA-level polymorphisms between two different wheat varieties?
 - a. Exons
 - b. Introns
 - c. UTRs
 - d. A and b
 - e. B and C

6. How many alleles at the storage protein locus do you expect in the H genome in any given barley plant?
 - a. 2
 - b. 4
 - c. 6
 - d. 8

7. How many alleles do you expect at the storage protein locus in the A genome in any given wheat plant?
 - a. 2
 - b. 4
 - c. 6
 - d. 8

8. How likely is it that you will obtain novel proteins due to crossing over between the storage protein loci in the A and B genomes of wheat?
 - a. Highly unlikely
 - b. Pretty likely
 - c. Very Likely
 - d. Daily

9. If you created a transgenic barley with a CaMV35S constitutive promoter regulating the storage protein gene, you would expect to find the storage protein
 - a. Only in seeds
 - b. Only in roots
 - c. Only in shoots
 - d. In all organs

10. If you crossed AABBDD wheat with HH barley, and successfully doubled the chromosome number of the resulting F1, you will have created
 - a. A diploid
 - b. A tetraploid
 - c. A hexaploid
 - d. An octaploid

11. Chromosome doubling, as in the preceding question #10, is due to
 - a. Failure of spindle fiber function
 - b. DNA polymerase with 2X activity
 - c. Increasing the number of replication origins per chromosome
 - d. All of the above

12. If you cross two wheat varieties whose storage protein alleles are identical at the loci in the A and B genomes but different at the D genome locus, what ratio do you expect for the D genome alleles in the F₂? Assume you visualize the alleles by protein electrophoresis and that the alleles show codominant inheritance.
- 1:1
 - 3:1
 - 1:2:1
 - 1:1:1:1
13. If a wheat variety has a mutation that leads to a loss of bivalent pairing, you would expect this plant to show
- Sterility
 - Fertility
 - Chromosome doubling with each mitosis
 - No change in phenotype
14. The chromosome 1B:1R translocation is of great importance in wheat. This means that
- On chromosome 1 of wheat there is a duplication of important genes
 - On chromosome 1 of wheat, there was breakage and reunion of chromatin in a reverse orientation
 - In an intergeneric hybrid between wheat and rye there were breaks in chromosomes 1 of wheat and rye, followed by the attachment of the rye chromosome 1 to wheat chromosome 1
 - None of the above
15. Some humans have celiac disease caused by an allergic reaction to specific wheat proteins. This painful condition is caused by
- DNA sequences interacting with specific human tissues
 - RNA sequences interacting with specific human tissues
 - Amino acid sequences interacting with specific human tissues
 - All of the above
16. The seedless watermelon and seedless banana are examples of plant genetics applications with tremendous impact on consumer acceptance. Seedless watermelons are produced
- Asexually
 - From seed obtained by crossing 4x x 2x plants
 - By apomixis
 - Using RNA silencing

17. Which of the following is most descriptive of meiosis in a 3x watermelon plant?
- Translocation
 - Inversion
 - Attempted pairing of three chromosomes: two of which are homologous and one of which is homoeologous to the other two
 - Attempted pairing of three homologous chromosomes
18. Seedless bananas are propagated
- Asexually
 - From seed obtained by crossing 4x x 2x plants
 - By apomixis
 - Using RNA silencing
19. Which of the following is most descriptive of meiosis in a 3x banana plant?
- Translocation
 - Inversion
 - Attempted pairing of three chromosomes: two of which are homologous and one of which is homoeologous to the other two
 - Attempted pairing of three homologous chromosomes
20. Based on the assigned reading in *Science*, which crop is at greatest risk in terms of genetic vulnerability due to very extensive propagation of genetically identical individuals?
- Barley
 - Banana
 - Watermelon
 - Wheat
21. Assume you are producer of non-transgenic table beet and your neighbor is a producer of roundup ready (RR) sugar beet. Assume that the sugar beet and table beet are sexually compatible. If the RR sugar beet pollinates the table beet, the resulting F1 plants will all be
- Homozygous
 - Hemizygous
 - Susceptible to herbicide
 - Sterile
22. You wish to prove that your table beet was pollinated by your neighbors RR beet so you use PCR to specifically amplify the EPSPS gene in F2 plants. You visualize the PCR amplicons by electrophoresis. Which of the following would you expect?
- A 1:1 ratio of two different size PCR amplicons (as visualized by bands in a gel)
 - A 1:2:1 ratio of PCR amplicons
 - A 3:1 ratio of PCR amplicon presence vs. no amplicon

23. If the RR sugar beet pollinates the table beet, how many copies of the EPSPS gene do you expect in the endosperm of the F1 seed?
- a. 0
 - b. 1
 - c. 2
 - d. 3
24. Which of the following would you NOT expect to find in the construct conferring herbicide resistance?
- a. CaMV35S promoter
 - b. GUS reporter
 - c. Kanamycin resistance selectable marker
 - d. TNOS terminator

Upon graduation, you get a job managing a nursery specializing in seed propagation of native plants. Very little is known about the genetics of most species sold by the nursery. You set out to remedy the situation.

25. You observe that plants of species X never set seed when individual plants are grown in isolation. Each plant has perfect (hermaphroditic) flowers. Seed is set only when plants are grown in groups of very different looking plants. The most likely explanation is
- a. Obligate apomixis
 - b. Facultative apomixis
 - c. Separate male and female plants
 - d. Self-incompatibility
26. Species Y is of particular interest due to its beautiful flowers. The Kew Gardens database says the genome size is 640 Mb. Species Z is of interest due to its delicious fruits. The Kew Gardens database says that the genome size is 3,000 Mb. Based on this information, which of the following would be the most correct decision/conclusion:
- a. Species Y is diploid and Species Z is polyploid
 - b. Species Y is monoecious and species Z is dioecious
 - c. Given current technology, species Y would be a better choice for whole genome sequencing than species Z
 - d. Species Y will be a better choice for doubled haploid production than species Z

27. Different plants of species Q have seed of different colors: some plants have black seeds and some plants have white seeds. You self-pollinate a plant with black seeds and produce 100 progeny plants. 70 of the progeny plants have black seeds and 30 have white seeds. Which of the following is the most likely explanation for these results?
- The plant you self-pollinated was homozygous for seed color alleles at a single locus
 - The plant you self-pollinated was heterozygous for seed color alleles at a single locus
 - Seed color shows quantitative inheritance
28. In order to test the hypothesis you formulated in the preceding question (#27), you decide to perform a chi square test on the data. How many degrees of freedom would you use to test the hypothesis that the seed color data fit a 3:1 ratio?
- 1
 - 2
 - 3
 - 4
29. You select a different plant of species Q that has white seeds. You self-pollinate the plant and all progeny have white seeds. You self each these plants again and all their progeny have white seeds. Which of the following is the most likely explanation for these results?
- The plant you self-pollinated was homozygous for seed color alleles at a single locus
 - The plant you self-pollinated was heterozygous for seed color genes
 - Seed color shows overdominance
 - Seed color shows partial dominance
30. In your collection of native plants, you have a particularly stunning example of a cottonwood. However, this plant is very slow growing. You decide to genetically engineer this plant in order to accelerate its growth. If you engineer this cottonwood with a growth gene cloned from a bovine, the resulting plant would be best described as
- Transgenic
 - Cisgenic

31. You determine that disease susceptibility in a particularly attractive shrub is due to the presence of a “T” at nucleotide position 247 in gene Rex9i and that resistance is due to an “A” at the same nucleotide position. Which of the following best describes this polymorphism”
- AFLP
 - RFLP
 - SNP
 - SSR
32. Given the genetic situation described in question # 31, which of the following strategies for developing a resistant variety would likely be the most straightforward and least subject to both regulation and intellectual property issues?
- Cross resistant x susceptible, extract DNA from progeny and select those homozygous for A at nucleotide 247
 - Use the gene gun to transform susceptible plants with a gene construct based on the coding region from a resistant plant
 - Contract with the CIBUS company to use their proprietary “RTDS” technology to induce a single nucleotide substitution of A for T in a susceptible plant.
 - Double the chromosome number of a susceptible plant
33. The nursery next door has developed Roundup Ready transgenic versions of the same species you have in your nursery. An allohexaploid Roundup Ready plant (homozygous for the EPSPS gene in one of its genomes) pollinates a homozygous allohexaploid non-Roundup Ready plant of the same species. The hemizygous F1 plant is self-pollinated. What phenotypic ratio do you expect in the F2? Assume bivalent pairing.
- Segregating 9:3:3:1 for Roundup resistance: susceptibility
 - Segregating 3:1 for Roundup resistance: susceptibility
 - All Roundup resistant
 - All Roundup susceptible
34. An autotetraploid Roundup Ready plant homozygous for the EPSPS gene in one of its genes pollinates an autotetraploid non-Roundup Ready plant of the same species. Assume bivalent pairing. You expect all F1 plants to be resistant to Roundup.
- T
 - F

35. You create a hemizygous obligate apomict for the EPSPS gene. This plant sets 100 seeds. What is your expectation for the phenotypes of plants grown from these seeds?
- Segregating – some plants Roundup resistant and others susceptible
 - All plants susceptible to Roundup
 - All plants resistant to Roundup
 - No expectations – anything could happen
36. The principal drawback to the Agrobacterium method of gene transformation, as compared to the gene gun, is that all the transformed plants also have crown gall disease.
- T
 - F
37. If you were interested in obtaining intron and “dark matter” DNA sequence, what type of library would be most suitable?
- cDNA
 - Benton
 - Genomic
38. The type of molecular marker that is characterized by consensus sequences on either side of a variable number of repeats is a
- AFLP
 - RFLP
 - SNP
 - SSR
39. The temperature cycling used in PCR reactions is needed to
- stimulate restriction enzyme activity.
 - alternately allow for double strand DNA denaturation, primer binding, and primer extension.
 - force nitrogen containing bases to undergo phosphodiester bonding.
 - assist in incorporating radioactively labeled nucleotides.
40. Clones in a cDNA library will be shorter than the original genomic coding sequences because the
- promoters are removed.
 - telomeres shorten with each replication.
 - introns were removed during mRNA processing.
 - ribosomes removed unnecessary information.

41. The key attribute of dideoxy nucleotides that makes them useful for DNA sequencing is that they have no 3' OH group.
- a. T
 - b. F
42. If you could easily determine the DNA sequence of alleles at 100 loci in one diploid plant that was heterozygous at all loci, how many different alleles would you be able to detect?
- a. 100
 - b. 200
43. If epistasis is known to exist for two loci, altered patterns would be observed in what type(s) of progeny?
- a. F2
 - b. Testcross
 - c. Doubled Haploid
 - d. All of the above
44. Recessive alleles can be due to
- a. Gene deletion
 - b. Changes in gene sequence leading to altered transcription
 - c. Changes in gene sequence leading to altered translation
 - d. All of the above
 - e. None of the above
45. You get a job with a seed company and are assigned responsibility for ensuring purity of the company's F1 hybrid seed. Your boss is concerned that the F1 seed may not be 100% heterozygous: she thinks that there may be some selfed seed contaminants in the F1 seed. The ideal molecular marker for testing the F1 will be
- a. codominant.
 - b. dominant.
 - c. overdominant.
 - d. monomorphic.
46. The situation where two phenotypes are determined by the same gene is called
- a. codominance.
 - b. epistasis.
 - c. linkage.
 - d. pleiotropy.

A search using NCBI nucleotide reveals that a portion of the DNA sense strand for a gene encoding a wheat gliadin protein is

5' atg aag acc ttc atc 3' (JQ943405.1)

47. Which is the corresponding DNA antisense strand?
- 3' tac ttc tgg aag tag 5'
 - 5' tac ttc tgg aag tag 3'
 - 3' atg aag acc ttc atc 5'
 - 5' atg aag acc ttc atc 3'
48. Which is the corresponding mRNA sequence?
- 3' uac uuc ugg aag uag 5'
 - 5' uac uuc ugg aag uag 3'
 - 3' aug aag acc uuc auc 5'
 - 5' aug aag acc uuc auc 3'
49. Which is the correct translation?
- Met Lys Thr Phe Ile
 - Ile Phe Thr Lys Met
 - Phe Ile Met Lys Thr
 - Met Thr Lys Phe Ile
50. The mechanism by which a stop codon stops translation is that
- tRNAs with affinity to the stop codon always bring methionine.
 - polymerases have exonuclease activity.
 - there are no tRNAs with anticodons matching the stop codon.
 - the ribosomes pinch off the completed sequence of amino acids.
51. Transfer RNAs (tRNAs)
- are weighed and the average weight is used to calculate Svedberg units.
 - are very specialized, with each tRNA able to carry a specified amino acid.
 - are very generic, with each tRNA able to carry any of a number of amino acids.
 - are coded for by sequences in introns.
52. The point of attachment of an amino acid to a tRNA is
- at the anticodon.
 - at the 5' end.
 - at the 3' end.
 - at either the 5' or 3' end.

53. One RNA primer is sufficient for initiating replication of the leading strand whereas a new primer is needed for each Okazaki fragment on the lagging strand.
- a. T
 - b. F
54. An RNA primer is required to initiate DNA replication because
- a. DNA polymerase can only add nucleotides to a free 3' OH.
 - b. the RNA primer opens up the helix and makes single stranded DNA.
 - c. the RNA primer joins Okazaki fragments and remains in the daughter strands.
55. The DNA sequence between the transcription start site and the start codon is the
- a. Promoter
 - b. 5'UTR
 - c. ORF
 - d. 3'UTR
56. In "The gene for fragrance in rice" paper, the authors conclude that the functional basis for the difference between aroma vs. non-aroma alleles is complete deletion of the gene. This causes aroma to be dominant and lack of aroma to be recessive.
- a. T
 - b. F
57. The rRNA subunits in ribosomes are transcribed from DNA, but are not translated.
- a. T
 - b. F
58. What process gives rise to new combinations of alleles at different loci?
- a. recombination
 - b. translation
 - c. levitation
 - d. mutation
59. In higher plants, each chromosome has a single bidirectional origin of DNA replication located at the telomere.
- a. T
 - b. F
60. The RNA primers that initiate DNA replication in the S phase of mitosis

- a. are found only on lagging strands.
 - b. are eventually removed and replaced with the corresponding DNA nucleotides.
 - c. remain in the daughter strands until the organism dies.
 - d. are the sites where chromatid exchange occurs.
61. Single crossovers, 2-strand double crossovers, 3-strand double crossovers, and 4-strand double crossovers
- a. All give equal frequencies of parental and non-parental combinations of alleles
 - b. Give fewer non-parental than parental combinations of alleles
 - c. Have very different outcomes in terms of combinations of alleles at loci flanking the crossover event(s)
 - d. Are the principal source of new alleles
62. To convert cM to Mbp you can
- a. Multiply by 3.84
 - b. Divide by .789
 - c. Use the Haldane formula
 - d. Politely inform the Professor that this conversion is not possible
63. Two loci can be in the same linkage group but show independent assortment.
- a. T
 - b. F
64. Segregation refers to alleles at a single locus and independent assortment to alleles at two or more loci.
- a. T
 - b. F
65. In higher plants,
- a. almost all of the DNA seems to be coding for something.
 - b. the amount of DNA in the genome corresponds directly to evolutionary complexity.
 - c. the amount of DNA increases exponentially with each meiosis.
 - d. a lot of the DNA is composed of transposons, inside of transposons, inside of transposons...
66. Which of the following statements best describes a plant nuclear chromosome?
- a. Radioactive
 - b. Each chromosome consists of a single DNA molecule complexed with histone proteins
 - c. There are two DNA molecules per chromosome, attached at the centromere

Chromosome 3 is reported to be 150 centiMorgans long and two loci are shown at opposite ends of the chromosome 3 linkage map. One locus controls flower color (alleles *W* and *w* determine white and red, respectively) and the other controls resistance to a foliar pathogen (alleles *R* and *r* determine resistance and susceptibility, respectively). One parent is *WWRR* and the other is *wwrr*. Assume complete dominance at each locus. You score the two traits in 100 doubled haploid progeny and record the following data:

White and Resistant	White and Susceptible	Red and Resistant	Red and Susceptible
27	23	27	23

67. The non-parental classes are
- White/Resistant and Red/Susceptible
 - White/Susceptible and Red/Resistant
 - Not identifiable given these data
68. Because the two loci are reported to be on the same chromosome, you want to see if they are linked in your cross. To do so, you would divide
- The parental classes/100
 - The non-parental classes/100
 - The non-parental + parental classes/100
69. If you calculated that the frequency of non-parental combinations was 50% would you conclude that the report of the two loci being on the same chromosome is wrong?
- Yes
 - No
70. If you had data on loci every 5 cM on chromosome 3, would you be more confident that the *W* and *R* loci show independent assortment but are located on the same chromosome?
- Yes
 - No
71. In plants, the ancestral condition was dioecious. Monoecious and hermaphroditic plants evolved through the progressive elimination of sex chromosomes.
- T
 - F

72. Which of the following combinations of characters might be most typical of a highly successful invasive species?
- Self-incompatibility and non-bivalent pairing.
 - Obligate apomixis and diploidy.
 - Facultative apomixis and polyploidy.
 - Vegetative reproduction via stolons and aneuploidy.
73. In the case of double fertilization, the endosperm is $3n$ and will have two alleles from the “mother” and one allele from the father.
- T
 - F
74. In a tri-nucleate pollen grain,
- the mitochondria are all $2n$.
 - two of the nuclei will become sperms while the third will become the pollen tube.
 - the three nuclei will fuse to give triploid endosperm.
 - two of the nuclei will become tube nuclei while the third will become the sperm.
75. If a diploid organism is said to have 30,000 genes (which by convention is the number of genes at the “n” level), which of the following is the following is most correct?
- The organism has 30,000 loci
 - The organism has 60,000 loci
 - In a leaf cell nucleus the organism will have 30,000 genes
 - The organism has 30,000 alleles at each locus

		Second letter					
		U	C	A	G		
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G	
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G	
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G	