

PLNT2530 PLANT BIOTECHNOLOGY

MID-TERM EXAMINATION

11:30 am to 12:20 pm      Wednesday, February 26, 2020

Answer any combination of questions totalling to exactly 100 points. If you answer questions totalling more than 100 points, answers will be discarded at random until the total points equal 100. The questions total to 120 points. This exam is worth 20% of the course grade.

Hand in these question sheets along with your exam book. Question sheets will be shredded.

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Ways to write a readable and concise answer:

- i. Just answer the question. Save time by specifically addressing what is asked. Don't give irrelevant background if it doesn't contribute to the question that was asked.
  - ii. Avoid stream of consciousness. Plan your answer by organizing your key points, and then write a concise, coherent answer. Make your point once, clearly, rather than repeating the same thing several times with no new information.
  - iii. Point form, diagrams, tables, bar graphs, figures are welcome. Often they get the point across more clearly than a long paragraph.
  - iv. Your writing must be legible. If I can't read it, I can't give you any credit.
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1. (15 points) In your exam booklet, re-write the table, using the terms below. Some terms may be used more than once. Some may not be used at all.

	plastid	mitochondrion	nucleus
genome size (bp)			
copies of genome per cell			
chromosome topology			
number of genes			
inheritance			

maternal                      paternal                      both parents

1                      2                      <100                      > 100                      50 - 200                      10<sup>5</sup>

> 10<sup>4</sup>                                      10<sup>5</sup> - 10<sup>6</sup>                      10<sup>7</sup> - 10<sup>12</sup>

linear                      circular                      branched

2. (10 points) List two aspects of DNA structure that cause single-stranded DNA to spontaneously reanneal into double-stranded DNA.

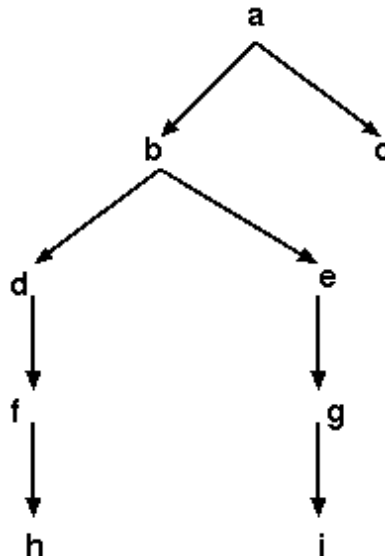
3. (5 points) Which of the following would you expect to see in a cDNA library:

- a) exon
- b) intron
- c) TATA box
- d) promoter
- e) 3'UTR

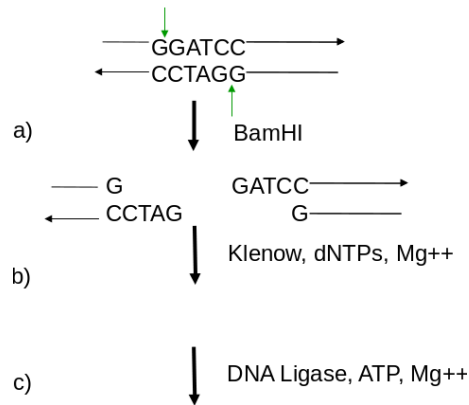
4. (5 points) PCR primers used to amplify a single gene from total genomic DNA are typically around 20 nucleotides long. Why can't these primers be, for example, 10 nucleotides long?  
Hint: See the table of Restriction Site Frequencies on page 7.

5. (10 points) Describe the purpose of a laminar flow hood. Explain how it works. Drawing a diagram may make it easier to answer this question.

6. (10 points) Redraw the diagram showing the differentiation of the plant body plan. Replace each of the letters a - i with one of the following terms: epicotyl, hypocotyl, embryo, cotyledon, root, shoot meristem, radicle, axis, root meristem



7. (15 points) In step a), the Bluescript vector was cut with BamHI, as illustrated in the accompanying figure. Redraw the figure, showing what the result would be after steps b and c.



The sequence of the region of the Bluescript vector that includes the BamHI site is shown below. This is the only BamHI site in the vector. We see that the BamHI site is within the protein coding region for the lacZ gene. Only the beginning of the protein coding region is shown.

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lacZ gene ----->
atg acc atg---> 802          787          772          KpnI          XhoI
ATG ACC ATG ATT ACG CCA AGC TCG AAA TTA ACC CTC ACT AAA GGG AAC AAA AGC TGG GTA CCG GGC CCC CCC TCG
TAC TGG TAC TAA TGC GGT TCG AGC TTT AAT TGG GAG TGA TTT CCC TTG TTT TCG ACC CAT GGC CCG GGG GGG AGC
MET Thr MET Ile Thr Pro Ser Ser Lys Leu Thr Leu Thr Lys Gly Asn Lys Ser Trp Val Pro Gly Pro Pro Ser

          SalI          ClaI          HindIII EcoRV          EcoRI          PstI          SmaI          BamHI SpeI          XbaI          NotI
          727          712          697          682          667
AGG TCG ACG GTA TCG ATA AGC TTG ATA TCG AAT TCC TGC AGC CCG GGG GAT CCA CTA GTT CTA GAG CGG CCG CCA
TCC AGC TGC CAT AGC TAT TCG AAC TAT AGC TTA AGG ACG TCG GGC CCC CTA GGT GAT CAA GAT CTC GCC GGC GGT
Arg Ser Thr Val Ser Ile Ser Leu Ile Ser Asn Ser Cys Ser Pro Gly Asp Pro Leu Val Leu Glu Arg Pro Pro
SacII          SacI
          652          637          622          607
CCG CGG TGG AGC TCC AAT TCG CCC TAT AGT GAG TCG TAT TAC AAT TCA CTG GCC GTC GTT TTA CAA C.....
GGC GCC ACC TCG AGG TTA AGC GGG ATA TCA CTC AGC ATA ATG TTA AGT GAC CGG CAG CAA AAT GTT G.....
Pro Arg Trp Ser Ser Asn Ser Pro Tyr Ser Glu Ser Tyr Tyr Asn Ser Leu Ala Val Val Leu Gln .....

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The Bluescript vector from step c) was transformed into *E. coli*, and grown on media containing antibiotic and Xgal. The resultant colonies were all white.

Explain the result.

8. (5 points) Explain the distinction between transposons and retrotransposons.

9. (10 points) For the following macroelements found used in tissue culture media, match each element with the phrase that best describes its role in the cell. To answer the question, simply write a list a - e, with the corresponding phrase. Only use each phrase once.

- a) Nitrogen (N)
- b) Potassium (K)
- c) Calcium (Ca)
- d) Magnesium (Mg)
- e) Phosphorus (P)

- i) nucleic acids, energy transfer, req'd in respiration and photosynthesis
- ii) enzyme cofactor, component in chlorophyll
- iii) proteins, nucleic acids
- iv) regulates osmotic potential, main inorganic cation
- v) cell wall structure, membrane function, signaling

10. (10 points) Consider the double-stranded duplexes shown below. Which duplex will be more stable, A or B? Which duplex will be more stable, C or D? In each case, explain your reasoning.

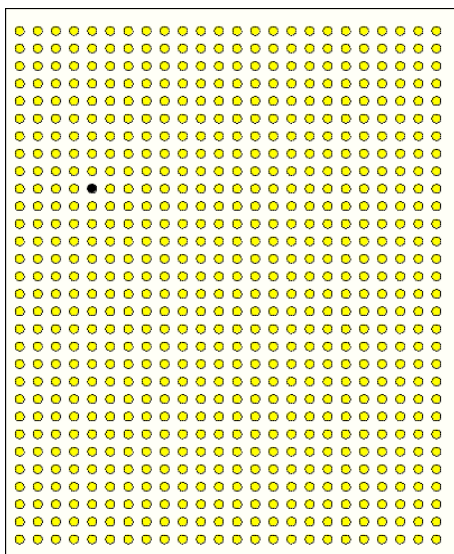
<p><b>A</b></p> <p>5' AACAAATCGTAAG 3'</p> <p>3' TTGTTAGCATTTC 5'</p>	<p><b>B</b></p> <p>5' AACTATCGTAAG 3'</p> <p>3' TTGTTAGCATTG 5'</p>
<p><b>C</b></p> <p>5' TCTGCTAACTGA 3'</p> <p>3' AGACGATTGACT 5'</p>	<p><b>D</b></p> <p>5' CCACTGACCTGG 3'</p> <p>3' GGTGACTGGACC 5'</p>

11. (5 points) Based on the data in the table below, which species, do you expect to have longer chromosomes, *Glycine max* or *Zea mays*? Explain your reasoning.

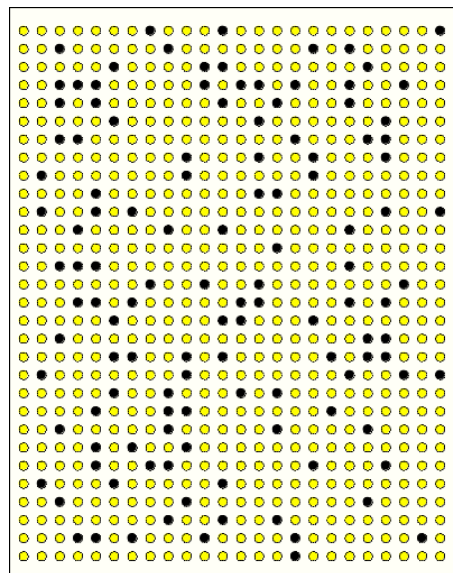
Organism	Chromosome number (n)	Genome size (bp)	Gene No.
<i>Arabidopsis thaliana</i>	5	$1.19 \times 10^8$	25,400
<i>Fragaria vesca</i>	7	$2.80 \times 10^8$	25,050
<i>Brassica rapa</i>	10	$2.84 \times 10^8$	41,174
<i>Oryza sativa</i>	12	$4.66 \times 10^8$	58,000
<i>Glycine max</i>	20	$1.10 \times 10^9$	46,430
<i>Zea mays</i>	10	$2.80 \times 10^9$	63,000
<i>Triticum aestivum</i>	21	$1.70 \times 10^{10}$	41,910

12. (10 points) A BAC library from pea (*Pisum sativum*) was screened with two probes. The first probe was a cDNA clone for pea defense gene DRR206. An identical filter was also probed using as a probe a 6 kb genomic fragment containing the DRR206 gene. Hybridization results for the two experiments are shown below. What is the most likely explanation for the different results? You can assume that trivial explanations such as probe contamination are not

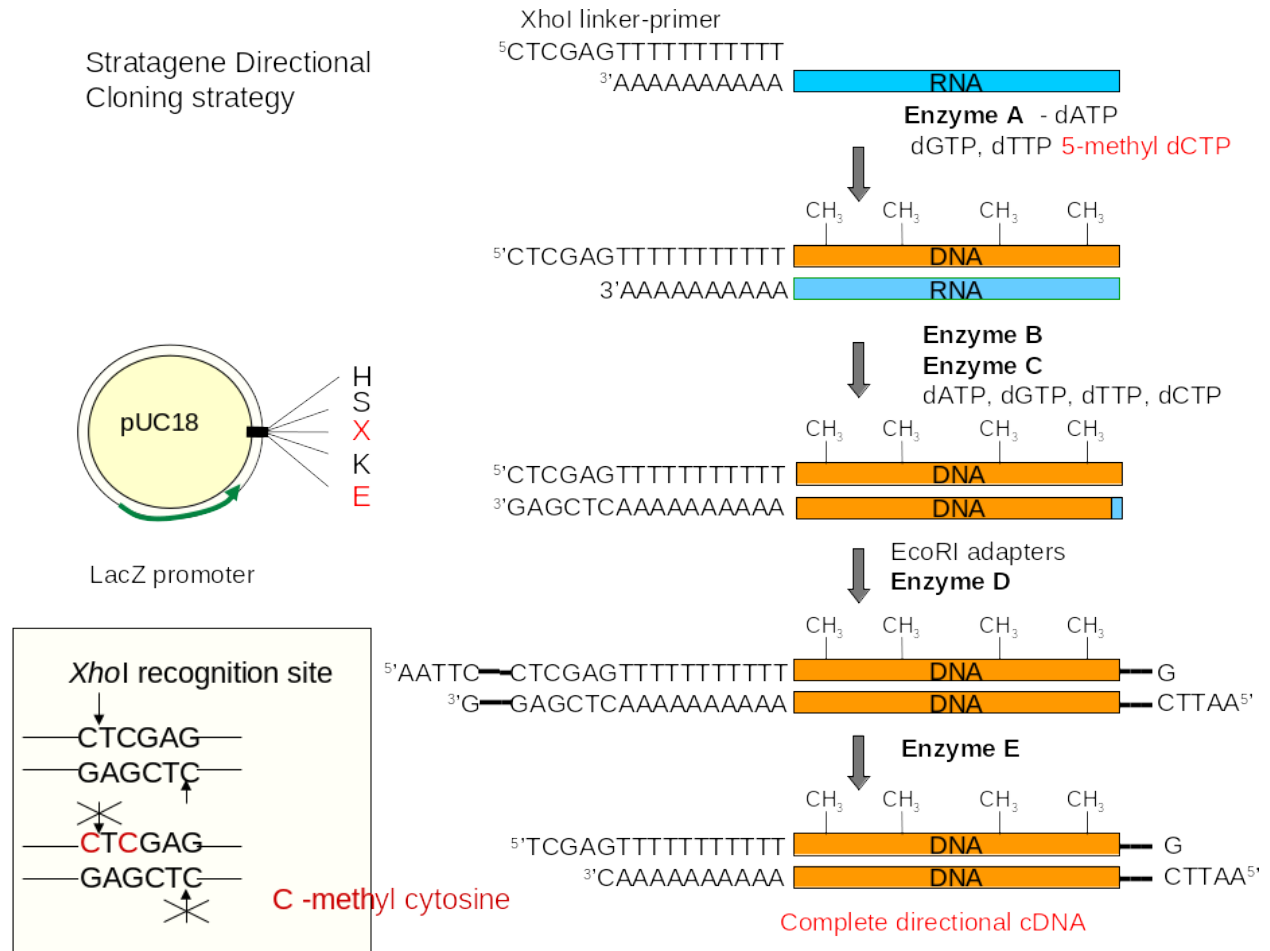
cDNA probe



6 kb genomic probe



13. (10 points) List the names of Enzymes A - E, used in the cDNA cloning protocol shown below.



# Genetic code

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

Met  
tRNA  
UAC

5' AUG codon  
mRNA

## Frequencies of Restriction Sites (or other oligonucleotides)

length n	frequency: occurs every 4 <sup>n</sup>	example	sequence
1	4	Single nucleotide	G
2	16	Di-nucleotide	GT
3	64	Codon	ATG
4	256	Taq I	TCGA
5	1024	MbolI	GAAGA
6	4096	Hind III	AAGCTT
7	16384	Abe I	CCTCAGC
8	65536	Not I	GCGGCCGC