1. The following data are from:

Ohta, S. 1995. Distinct numerical variation of B-chromosomes among different tissues in *Aegilops mutica* Boiss. Japan. J. Genet. 70:93-101.

Table 3. The distribution of Bs among the meristem cells in shoot apices and adventitious root tips of the plant 85504-9 with 2Bs in PMCs

| | No. o | No. of cells observed with: | | |
|-----------------------|-------|-----------------------------|-----|--------|
| Tissue: | 0B | 1B | 2B | Total: |
| Shoot apex | 0 | 0 | 655 | 655 |
| Adventitious root tip | 976 | 4 | 1 | 981 |

Use what you know about the behavior of B chromosomes to explain the results in table 3, shown above. Limit your answer to the space on this page.

2. The article at left was widely published in newspapers around the country a few years ago. The enzyme the article is referring to is telomerase.

A) Why do chromosomes have telomeres, and how do telomeres function?

B) What is telomerase, and why would it be associated with cancer?



A new discovery by University of Chicago biologists may help unlock one of the key mysteries of cancer:

3. The data at right are from:

Zhang, Q., MAS Maroof, and RW Allard. 1990. Effects on adaptedness of variations in ribosomal DNA copy number in populations of wild barley (*Hordeum vulgare* spp. *spontaneum*). Proc. Natl. Acad. Sci. USA 87:8741-8745.

In this study, the authors looked at the copy number of rDNA in 101 accessions of wild barley. Their purpose was to

determine if there was a relationship between rDNA copy number and fitness. There was not, but their data raise a fundamental question. How can there be so much variation between rDNA copy number within a single species?



- **4.** A. State 3 functions of the telomeres
 - B. Describe fully the behavior of B chromosomes that made them so useful to study the nature of the NOR
 - C. Why is NOR gene copy so variable?

5. The following idiograms are from:

D=Emerico, S., S. Cozzolino, G. Pellegrino, D. Pignone, and A. Scrugli. 2002. Bot. J. Linn. Soc. 138:85-95.

The top idiogram (a) is of *Dactylorhiza romana*, an orchid, while the bottom one (b) is of *D. saccifera*. The blackened areas indicate heterochromatic regions.



Both species are 2n = 2x = 40. Why are 21 chromosomes shown from *D. romana*, and what are your reasons for saying so?

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6. Source: Wagner, R.P., M.P. Maguire, and R.L. Stallings. 1993. Chromosomes: A Synthesis. Wiley-Liss, Inc. New York.

At right is an electron micrograph of chromatin loops, with the nuclear scaffold at the bottom.

- \$ The DNA sequences which bind to the matrix are called what?
- \$ Describe how the DNA is organized or packaged into loops.



7. The following is from:

http://www.cropsci.uiuc.edu/faculty/hymowitz/genlab/karyo.html



Give a written description of the karyotype of soybean based on this drawing. Written descriptions usually include numbers of chromosomes that are metacentric, telocentric, etc., along with the numbers of types of other landmarks.

8. The folks from *Businessweek* magazine published the following diagram on 03-Apr-2003.

What inferences might an inadvertent reader get on chromosome biology, given the depiction of the plant nucleus in the diagram? Explain your answer.

PLANT CELL

DNA

NEW PLANTS

NUCLEUS

Your answer should not exceed 1 or 2 sentences on the space remaining on this page

FOOLING MOTHER NATURE TRANSGENIC PLANTS WITH ENTIRELY NEW ATTRIBUTES ARE MADE BY SPLICING THE GENE OF ONE SPECIES INTO ANOTHER

A piece of DNA with the desired traits to be added to the plant is selected. Then units of ring-shaped DNA called plasmids are pulled out of a microbe called agrobacterium. The plasmid ring is snipped open, the DNA is inserted into the circle, and the re-engineered circle is put back into the agrobacterium.





2 A piece of a leaf from example, is put into a solution with the agrobacterium, which hooks on to one of the leaf's plant cells. The altered plasmid transfers the DNA into the plant cell.

DATA BUSINESS WEEK MAGAZINE COBW

3 The foreign transferred nucleus of the p

3 The foreign DNA is transferred into the nucleus of the plant cell, where it becomes part of the plant's chromosomes.

PETRI DISH

4 The plant cell is cultivated until it divides and grows into new plants with the alien DNA encoded in their genes.

5 The plants with new traits are then transferred to soil.

9. The following is from:

http://www.geneconserve.pro.br/Goias Brazil.htm

Cassava is a diploid root crop that is one of the most important sources of calories for the tropics.

A) Name the stage of meiosis in the photo below

B) Based on the photo, provide the coefficients for x, c and give the total chromosome number

 $2n = ___ x = ___ c = __$

C) Extra Credit. Three of the bivalents have been labeled with arrows. For each of these, provide an interpretive drawing. These should show the centromeres and the crossovers. Specify if the chromosomes are meta, acro or telocentric.







10. The following cover graphic is admittedly supposed to be artistic rather than accurate.

It depicts an interphase nucleus.

In the interest of accuracy, what is wrong with the chromosomes in this illustration?



11. The following is from:

Cruz et al., 2017. Cytogenetic markers for the characterization of *Capsicum annuum* L. cultivars. Plant Biosystems 151: 84-91.

- A) 3 pairs of chromosomes have had white boxes put near them. Within those 6, match each chromosome with is homolog by writing 1, 2 or 3 in each box
- B) Describe the landmarks and other morphological features used to match each of the three pairs in part A. Do not exceed the space provided for your answer.



12. The following is from:

https://twitter.com/GeneticLiteracy/status/866655004161183744/photo/1



The adjacent photo illustrates a news article on a genetics-related topic. Skilled as the graphic artist must be, their chromosome biology is off: Why is the ideogram shown here incorrect?

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13. The following is from:

Wu DD, A Ruban, J Fuchs, J Macas, P Novák, M Vaio, YH Z & A Houton. 2019. Nondisjunction and unequal spindle organization accompany the drive of *Aegilops speltoides* B chromosomes. New Phytologist 223: 1340–1352.

In this paper, the authors used B-chromosome specific sequences and FISH to trace the fate of B chromosomes. They found that the B's separate equally at mitosis 6.67% of the time. Then, 3.33% of the time, they both end up in the vegetative cell, and 85% of the time they both end up in the generative cell.

A. What is this phenomenon known as?

B. Will B's continue to accumulate with every cycle of meiosis, or is their accumulation reversible, and why?



14. The following figure is from <u>https://cytogenetics.wustl.edu/</u>



List/explain all the changes that need to be made for the figure to biologically correct:

No. of Concession, Name