DO NOT OPEN UNTIL TOLD TO START

BIO 312, Section 1: Fall 2012
September 25th, 2012 – Exam 1

Name (print neatly) _____

Signature _____

7 digit student ID _____

INSTRUCTIONS:

1. There are 14 pages to the exam. Make sure you have all of the pages.
2. There are 45 scantron problems.
3. Each problem will count equally to your overall score.
4. Be sure to provide your student information on this page and on the scantron.
5. Mark all of your answers clearly on the scantron using a #2 pencil.
6. You have 65 minutes to complete the exam.
7. When you are done, turn in both your exam copy **with your signature** and your scantron.
8. Keep your eyes on your own exam, keep your exam concealed (do not hold up).
9. You may use a calculator but not any other electronic devices.

Instructions: For each problem choose the correct answer from the provided choices. On the scantron, fill in the circle underneath the letter of your selected answer using a number 2 pencil.

The below text is for problems 1 - 6.

A research group indentified a mutant mouse that exhibits a premature aging phenotype. To understand the genetic cause of the premature aging, a _____1_____ investigation was done by crossing a premature aging mouse to a wild type pure line that age normally. All resulting F1 progeny aged normally. When F1 progeny were crossed to each other, 10 of 40 F2 progeny had the premature aging phenotype. Therefore the premature aging phenotype results from _____2_____ .

A mutation was suspected in the gene *LamininA*, which contributes to the premature aging phenotype. So the research group used _____3_____ to cut chromosomal DNA from F2 progeny mice into smaller fragments. Following electrophoresis, _____4_____ was done with a *LamininA* labeled DNA probe. From this, the group found that individuals with normal aging had either a large band or both a large and small band, whereas premature aging individuals had only the short band. The group used electrophoresis to separate proteins extracted from F2 progeny liver tissue. Then an antibody probe that interacts with the LamininA protein was used for _____5_____ . The group found that the antibody failed to detect any LamininA protein in the liver tissue of the premature aging mice. They interpreted the absence of LamininA protein to indicate that the mice with the premature aging phenotype had a *LamininA* gene _____6_____ allele.

Choose the answer which best completes the above text.

1. A. molecular genetic B. reverse genetic C. forward genetic
D. phylogenetic E. systematic

2. A. a recessive mutation in one gene B. recessive mutations in two genes
C. a dominant mutation in one gene D. dominant mutations in two genes
E. a dominant mutation in one gene and a recessive mutation in a second gene

3. A. RFLP B. probes C. PCR
D. antibodies E. restriction enzymes

4. A. Southern blotting B. western blotting C. northern blotting
D. RFLP E. PCR

5. A. Southern blotting B. western blotting C. northern blotting
D. RFLP E. PCR

6. A. wild type B. null C. neutral D. leaky

7. If we call the amount of DNA per genome *"x,"* name a situation or situations in diploid organisms in which the amount of DNA per cell is *4X*

A. After S phase but before completion of meiosis I.
B. After meiosis I but before completion of meiosis II.
C. After S phase but before completion of mitosis
D. Both A and B
E. Both A and C

8. Two black guinea pigs were mated and over several years produced 29 black and 9 white offspring. Is black or white dominant and what were the parent's genotypes?

(*B* = black allele and *W* = white allele)

A. Black is dominant and the parental cross was *B/W* x *B/W*
B. White is dominant and the parental cross was *B/W* x *B/W*
C. White is dominant and the parental cross was *B/B* x *B/W*
D. Black is dominant and the parental cross was *B/B* x *B/W*
E. Black is dominant and the parental cross was *B/-* x *B/-*

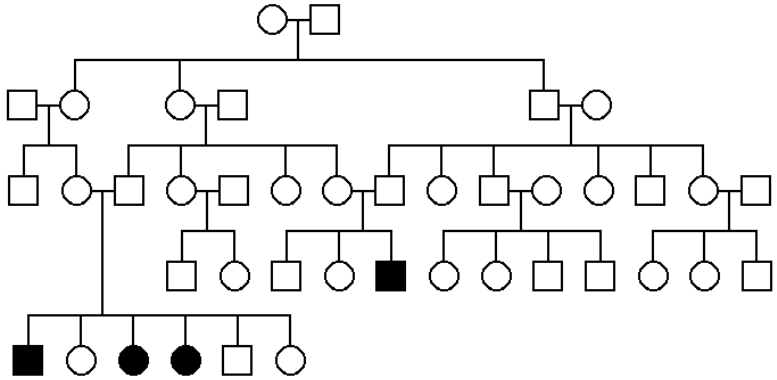
9. From a large-scale screen of many plants of *Collinsia grandiflora*, a plant with three cotyledons was discovered (normally, there are two cotyledons). This plant was crossed with a normal pure-breeding wild-type plant, and 600 seeds from this cross were planted. There were 298 plants with two cotyledons and 302 with three cotyledons. What can be deduced here? (mutant allele called "*3*" and wild type allele called "*2*")

A. mutant allele is recessive to the wild type allele, and mutant parent had genotype of *3/2*
B. mutant allele is dominant over the wild type, and mutant parent had a genotype of *3/3*
C. mutant allele is dominant over the wild type, and mutant parent had a genotype of *3/2*
D. mutant allele is recessive to the wild type allele, and mutant parent had genotype of *3/3*

10. Which of the following is/are NOT TRUE about the human Y chromosome?

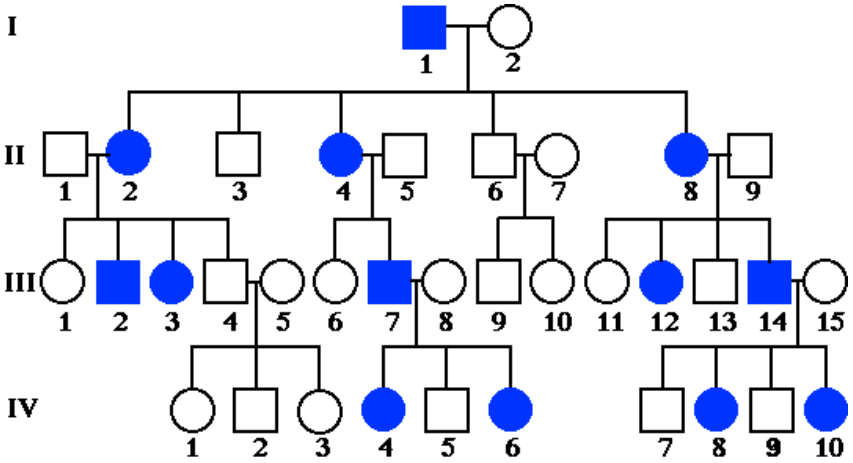
A. The Y chromosome ends are similar to the X chromosome ends.
B. The Y chromosome has a gene called *SRY*.
C. The Y chromosome has more genes than the X chromosome.
D. The Y chromosome has fewer genes than the X chromosome.
E. Both choices A and B are NOT TRUE.

11. In the family below, several individuals have a disorder called Usher Syndrome, a very rare condition where affected individuals lose their vision and hearing during childhood (filled in shapes). Based on the distribution of affected individuals, what is the pattern of inheritance?



A. autosomal recessive
B. autosomal dominant
C. cytoplasmic
D. X-linked recessive
E. X-linked dominant

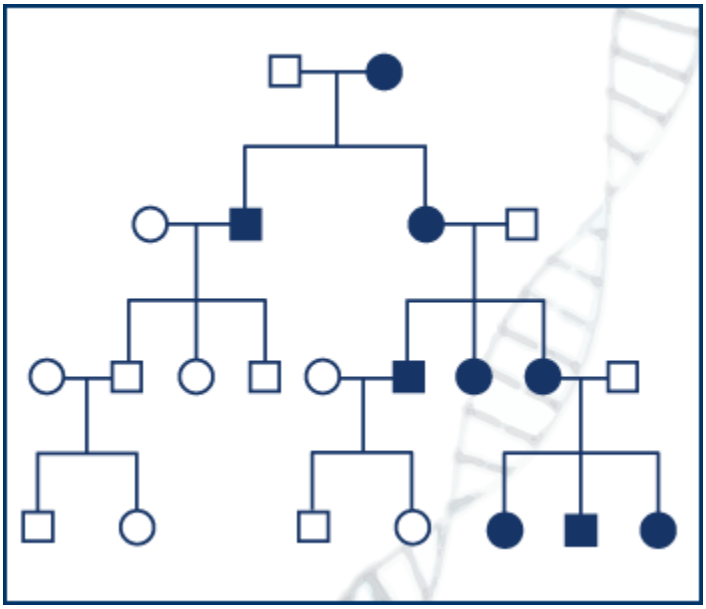
12. Many individuals (filled in shapes) from the family below have Charcot-Marie-Tooth disease, a very rare condition where affected individuals have a progressive loss of muscle tissue during their lives. Based on the distribution of affected individuals within the pedigree, what is the best supported pattern of inheritance for this disease?



Pedigree 5. X-linked dominant inheritance.

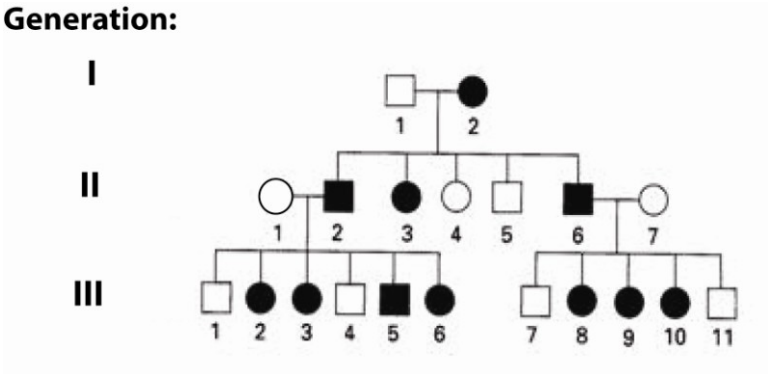
A. autosomal recessive
B. autosomal dominant
C. cytoplasmic
D. X-linked recessive
E. X-linked dominant

13. Several individuals (filled in shapes) within the below family have Leber's hereditary optic neuropathy, a very rare condition where affected individuals lose their vision during their young adulthood. What pattern of inheritance best explains the distribution of affected individuals?



A. autosomal recessive B. autosomal dominant C. cytoplasmic
D. X-linked recessive E. X-linked dominant

14. Several individuals within the family below (black shapes) have a very rare disease known as familial hypercholesterolemia, where affected individuals have an abnormally high cholesterol level that leads to early cardiovascular disease. What pattern of inheritance best explains the distribution of affected individuals?

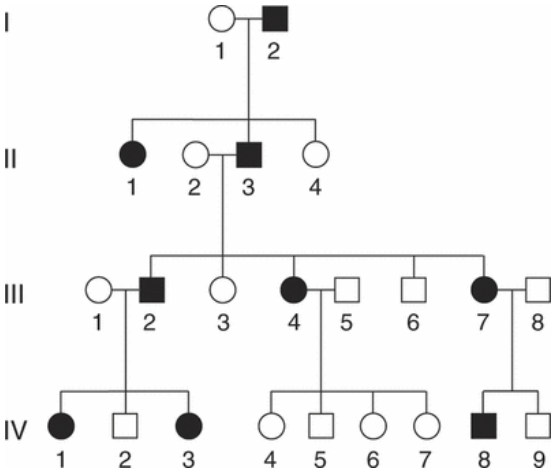


A. autosomal recessive B. autosomal dominant C. cytoplasmic
D. X-linked recessive E. X-linked dominant

15. An X-linked dominant allele causes hypophosphatemia in humans. A man with hypophosphatemia marries a normal woman. What proportion of their sons will have hypophosphatemia?

A. 0 B. ¼ C. ½ D. ¾ E. 1

For 16 and 17. The accompanying pedigree is for a very rare, but relatively mild, hereditary disorder of the skin. The gene is called *D*.



16. What are the genotypes for individuals II4 and III2?

A. II4 = *d/d* and III2 = *D/d*
B. II4 = *D/d* and III2 = *d/d*
C. II4 = X^D/X^d and III2 = X^d/Y
D. II4 = X^d/X^d and III2 = X^D/Y
E. II4 = *d/d* and III2 = *D/D*

17. If individual IV3 and IV9 decided to have children, then what proportion of their male children would be expected to have this skin disorder?

A. 0 B. ¼ C. ½ D. ¾ E. 1

For 18 and 19. Assume independent assortment and start with a plant that is dihybrid *A*/*a* ; *B*/*b*

18. What phenotypic ratio is produced from selfing it?

A. 3:1 B. 1:1:1:1 C. 1:2:1 D. 9:3:3:1 E. 1:1

19. What genotypic ratio is produced from testcrossing it?

A. 3:1 B. 1:1:1:1 C. 1:2:1 D. 9:3:3:1 E. 1:1

20. Normal mitosis takes place in a diploid cell of genotype *A*/*a* ; *B*/*b*. Which of the following genotypes might represent possible daughter cells?

A. *A*; *B*
B. *a*; *b*
C. *A*; *b*
D. all of the above
E. *A/a* ; *B/b*

21. Tomato plants can have hairy or smooth leaves due to alleles for gene *H* (*H* = hairy leaves; *h* = smooth leaves) and can have round or elongated ovaries due to alleles for gene *R* (*R* = round ovary; *r* = elongated ovary.) A plant was "self crossed" and the following types and numbers of plants were identified:

hairy, round	178
hairy, elongated	62
smooth, round	56
smooth, elongated	24

What was the genotype for the self crossed parent?

A. *H/-* ; *R/-* B. *H/h* ; *R/r* C. *H/h* ; *R/R* D. *HR/hr* E. *H/H* ; *R/R*

22. The taste of a Macintosh apple requires a tree to have the collective PHENOTYPE for six genes:

Macintosh PHENOTYPE: **A, B, c, D, e, and F** (capital = dominant, lower case = recessive)

If a tree of the below GENOTYPE is "self crossed", what proportion of the progeny would be expected to have the Macintosh PHENOTYPE?

Tree GENOTYPE: ***A/a* ; *B/b* ; *c/c* ; *D/d* ; *e/e* ; *F/f***

A. 1/4,096 B. 1/256 C. 1/16
D. 81/256 E. 729/4,096

23. When does crossing over occur to make recombinant genotypes and between what?

A. Before DNA replication for meiosis and between sister chromatids.
B. During meiosis I and between non-sister chromatids.
C. During meiosis I and between sister chromatids.
D. During meiosis II and between non-sister chromatids.
E. During meiosis II and between sister chromatids.

For 24 - 27. In fruit flies, two alleles of one gene determine the character difference of "**planar**" (**P**) versus "**curly**" (**C**) wings, and two alleles of a separate gene determine the character difference of "**large**" (**L**) versus "**small**" (**S**) body size. The progeny results for five fruit flies matings between parents with the listed phenotypes were as follows:

Mating	Parental phenotypes	Number of progeny with phenotype			
		P, L	P, S	C, L	C, S
1	P, L X C, S	102	99	103	99
2	C, S X C, S	51	151	149	452
3	P, S X C, L	0	0	74	75
4	P, S X C, L	52	51	49	50
5	P, L X C, L	0	205	203	0

24. Determine which alleles are dominant.

A. P and C
B. C and L
C. P and L
D. C and S
E. P and S

25. What are the most probable genotypes for the parents in cross 1?

A. *C/P ; S/L* x *C/P ; S/L*
B. *P/P ; L/L* x *C/P ; S/L*
C. *P/P ; S/L* x *C/P ; S/L*
D. *C/P ; L/L* x *C/P ; S/L*
E *P/P ; L/L* x *C/P ; S/S*

26. What are the most probable genotypes for the parents in cross 3?

A. *C/P ; S/L* x *C/P ; S/L*
B. *P/P ; L/L* x *C/P ; S/L*
C. *P/P ; S/L* x *C/C ; L/L*
D. *C/P ; L/L* x *C/P ; S/L*
E. *P/P ; S/L* x *C/P ; S/S*

27. What are the most probable genotypes for the parents in cross 4?

A. *C/P ; S/S* x *C/P ; S/L*
B. *P/P ; L/L* x *C/P ; S/L*
C. *P/P ; S/L* x *C/P ; S/L*
D. *C/P ; S/S* x *C/C ; S/L*
E. *P/P ; S/L* x *C/P ; L/L*

28. The parental cross ***E*/*E* · *F*/*F* × *e*/*e* · *f*/*f*** is made, and the F_1 is then backcrossed with the recessive parent. The progeny genotypes are inferred from the phenotypes. The progeny genotypes, written as the gametic contributions of the heterozygous parent, are in the following proportions:

$E \cdot F \qquad \frac{2}{6}$

$E \cdot f \qquad \frac{1}{6}$

$e \cdot F \qquad \frac{1}{6}$

$e \cdot f \qquad \frac{2}{6}$

The results indicate that:
A. The genes *E* and *F* are assorting independently
B. The genes *E* and *F* are linked and are separated by 16.7 map units
C. The genes *E* and *F* are linked and are separated by 33.3 map units
D. The genes *E* and *F* are linked and are separated by 8.3 map units
E. The genes *E* and *F* are linked and are separated by 66.6 map units

For 29 and 30. If ***A*/*A* · *B*/*B*** is crossed with ***a*/*a* · *b*/*b*** and a resulting F_1 is testcrossed.

29. What percentage of the testcross progeny will be ***a*/*a* · *b*/*b*** if the two genes are unlinked?

A. 0% B. 12.5% C. 25% D. 50% E. 100%

30. What percentage of the testcross progeny will be ***a*/*a* · *b*/*b*** if the two genes are 20 m.u. apart?

A. 0% B. 10% C. 20% D. 40% E. 80%

For 31 – 34. A geneticist crossed two different pure-breeding lines of corn to obtain a phenotypically wild-type F_1 plant that was heterozygous for three genes with dominant and recessive variants (*An* and *an* affect anther shape; *Br* and *br* affect leaf size; and *F* and *f*, affect tassel type). She testcrossed the F_1 with a tester that was homozygous recessive for the three genes. The following genotypes were inherited from the heterozygous parent:

Genotypes	Number of Progeny
An Br F	**23**
an br f	**22**
An Br f	**658**
an br F	**667**
An br f	**255**
an Br F	**260**
An br F	**56**
an Br f	**59**
Total	**2000**

31. What are the gamete genotypes of the two pure-breeding parental lines?

A. *An br F* and *an Br f*
B. *An br f* and *an Br F*
C. *An Br f* and *an br F*
D. *An Br F* and *an br f*
E. *An Br f* and *an Br f*

32. Which gene is in the middle?

A. *An*
B. *Br*
C. *F*

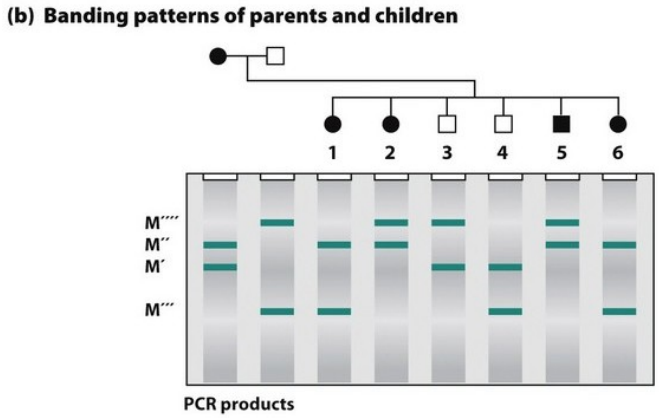
33. What is the distance in map units (rounded to nearest integer) between *An* and *Br*?

A. 2
B. 8
C. 28
D. 32
E. 36

34. What is the distance in map units (rounded to nearest integer) between *An* and *F*?

A. 2
B. 8
C. 28
D. 32
E. 36

For 35 and 36. The figure below includes a pedigree for a family with a heritable genetic condition, and a gel electrophoresis revealing PCR genotypes for a molecular marker. This molecular marker has alleles which differ in their number of tandem dinucleotide repeats (repeat lengths of 2 base pairs). Each gel lane (column) refers to the genotype for the individual directly above in the pedigree.



35. What type of molecular marker was used above?

A. SNP B. RFLP C. DGE D. microsatellite
E. segmental duplication

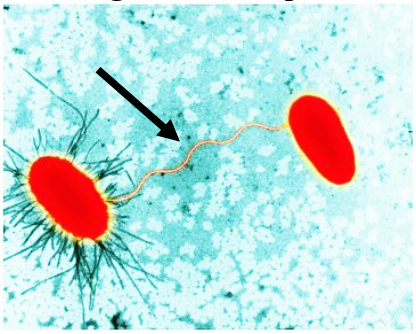
36. Do any of the molecular markers appear linked to this genetic disease?

A. M' B. M'' C. M''' D. M''''
E. none of the above

37. True or False: Simultaneous resistance to several antibiotic drugs by formerly sensitive strains of the same and different bacterial species can occur by the spreading of resistance genes on R plasmids.

A. True B. False

Use image below for problems 38 and 39.



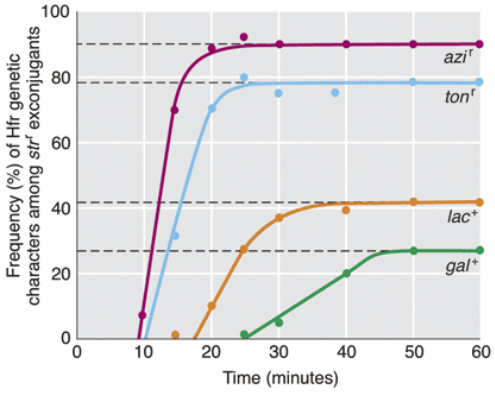
38. What is the name of the structure connecting these two bacterial cells (indicated by arrow)?

A. Chiasma B. Exogenote C. Endogenote D. Pilus E. Plaque

39. What form of genetic exchange does this structure help mediate?

A. Transformation B. Specialized Transduction C. Generalized Transduction
D. Conjugation E. Transfection

For 40 and 41. The figure below is data from an interruption mating experiment that tracked the transfer of Hfr gene alleles to F- recipient cells.



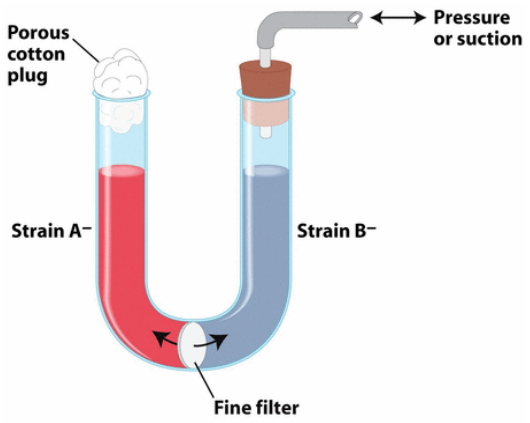
40. Where is the position of the fertility factor in the Hfr cells?

A. there is no fertility factor here B. plasmid C. prophage
D. chromosome E. lysogen

41. What process of genetic exchange is occurring here?

A. Transformation B. Specialized Transduction C. Generalized Transduction
D. Conjugation E. Transfection

For problems 42 and 43.
Strain A- and B- each fail to grow when plated on a Petri dish with minimal medium. When these strains are first cultured together some colonies are found that can grow on minimal medium.



42. Strain A- and B- are considered to be

A. auxotropic B. prototrophic C. heterotrophic D. pleiotropic

43. Cultures of strain A- and B- were placed in separate halves of a U-tube as shown above. Using pressure and suction, the media but not cells were passed from one side of the fine filter to the other. Following this media exchange, strain A- and B- cells were taken and plated on minimal medium and some colonies developed. From this result, it can be concluded that the original growth on minimal medium is caused by the process known as
.....

A. transformation. B. conjugation. C. transfection.
D. recombination. E. transduction.

Problems 44 and 45. Scientist studying a strain of bacteria isolated from a cow's rumen are interested in the chromosome structure for two genes involved in metabolizing cellulose. They performed **generalized transduction** experiments on a strain that is sensitive to the antibiotic Vancomycin (van^S) and mutant for two additional genes.

Donor: van^R $starch^+$ $sugar^+$ Transduced Strain: van^S $starch^-$ $sugar^-$

Three experiments were performed, each starting with recipient transductants that were selected for a certain marker or markers. For each experiment, positive transductants were then tested for the presence of an unselected marker or markers (so-called co-transduction events). The percentage of transductants with the unselected markers are presented below.

Experiment	Selected marker	Unselected Marker
1	$sugar^+$	55% $starch^+$; 10% van^R
2	$starch^+$	52% $sugar^+$; 2% van^R
3	$sugar^+$ $starch^+$	1% van^R

44. Which gene is the *van* gene closer to?

A. *starch* B. *sugar*

45. This method of genetic exchange requires .....

A. pili joining together the two bacterial strains.
B. a fertility factor integrated into the host bacterial chromosome.
C. a lysogenic bacterium.
D. a virulent phage (no prophage).
E. an R-plasmid.