ID # _____

Bio97 Section A 2006 NAME: _____

Useful information:

First Letter		U		C		A		G	
	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	Tryp
	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

Letter

$H^2 = \sigma_g^2/\sigma_p^2$

$M' = M + h^2(M^*-M)$

$n = D^2/8\sigma_g^2$

$\sigma_p^2 = \sigma_g^2 + \sigma_e^2$

ID # _____

FOR THE ENTIRE EXAM: DECIMAL ANSWERS MUST BE TO TWO DECIMAL PLACES AND FOLLOW CONVENTIONAL RULES FOR ROUNDING (4 rounds down, 5 rounds up).

MULTIPLE CHOICE: There is only one correct answer for each question. Each is worth 1 point.

1. Several Hfr strains are mated with an auxotrophic F- strain by the interrupted mating technique. The order of transfer for the loci are given in the table:

strain 1	strain 2	strain 3	strain 4
thr	str	his	thy
lip	thy	thy	his
trp	his	str	trp
his	trp	ilv	lip
thy	lip	thr	thr

What is the order of the loci on the chromosome?

A. str-thy-his-trp-lip-ilv-thr
B. trp-lip-trp-his-thy-str-ilv
C. thy-his-trp-lip-thr-thy-his
D. thr-lip-trp-his-thy-str-ilv
E. thr-lip-trp-his-thy-ilv-str

2. An autosomal recessive disease, bari-bari, occurs with an incidence of 0.30 among seals. What would be the frequency of heterozygous carrier seals for bari-bari, assuming Hardy-Weinberg equilibrium?

A. 0.27
B. 0.36
C. 0.43
D. 0.31
E. 0.50

3. If there is one crossover in every 50 cells undergoing meiosis, this is equivalent to:

A. 0.5 map units
B. 1 map unit
C. 10 centiMorgans
D. 2% recombination
E. .2 map units

4. Which one of the following statements is FALSE?
   A. In the lysogenic cycle of bacteriophage, no progeny phage are produced.
   B. Phage DNA replicates using host polymerases.
   C. In the lysogenic cycle, each bacterial progeny cell receives a phage DNA molecule.
   D. Only the prophage are capable of the lysogenic cycle.
   E. Phage DNA can recombine in the host to generate recombinant phage.

5. Three crosses were performed involving the linked genes Guss, Lass and Dmb. The Guss gene has alleles G and g, the Lass gene has alleles L and l, and the Dmb gene has alleles D and d. The genotypes obtained, and the frequency at which they were obtained, is given below:

GL/gl x gl/gl	46% GL, 48% gl, 2% Gl, 4% gL
LD/ld x ld/ld	45% LD, 47% ld, 4% Ld, 4% lD
GD/gd x gd/gd	43% GD, 43% gd, 7% Gd, 6% gD

   The best map of the Apa, Bass and Dmb genes is:
   A. Guss ---3cM--- Lass ---4cM--- Dmb
   B. Dmb ---8cM--- Lass ---6cM--- Guss
   C. Lass ---6cM--- Guss ---13cM--- Dmb
   D. Lass ---4cM--- Dmb ---7.5cM--- Guss
   E. Dmb ---4cM--- Lass ---2cM--- Guss

6. Which one of the following statements is TRUE?
   A. The centromeres of sister chromatids separate at the first meiotic division in *Neurospora*.
   B. It is not possible to determine whether a cross-over between two loci occurred in non-ordered tetrads.
   C. Four patterns of first-division segregation are possible in ordered octads.
   D. The order of spores in the ascus of the ordered octad indicates whether a cross-over occurred between two loci during meiosis.
   E. Cross-overs between two loci can occur before replication, as proven by tetrad analysis.

7. Which one of the following statement is FALSE?
   A. When environmental effects on phenotype differ according to genotype, this is termed genotype-environment interaction.
   B. Most common disorders in human families are multifactorial.
   C. A threshold trait is due to a single gene, and individuals with a mutation in this gene display differing thresholds for the trait.
   D. Linking QTLs to the SSR map is an essential part of identifying the genes that affect a quantitative trait.
   E. The variance calculated from a distribution of phenotypes equals zero when all individuals have the same phenotype.

ID # _____

8. Bacterial resistance to antibiotics is a real problem in hospitals. Which of the following mechanisms DOES NOT contribute to this?

A. Resistant bacteria can degrade the antibiotic.
B. Resistant bacteria can change their cell walls so that the antibiotic won't affect them.
C. Resistance genes can be encoded within tranposable elements.
D. Resistant bacteria can pump antibiotics out.
E. Resistance genes can rapidly spread through conjugation.

9. The MN blood group phenotypes of 2000 British citizens are 596M, 978MN, 426N. Which of these statements is TRUE?

A. The frequency of the MM genotype is .30 and the frequency of the N allele is .92.
B. The frequency of the MM genotype is .30 and the frequency of the N allele is .46.
C. The frequency of the MM genotype is .60 and the frequency of the N allele is .92.
D. The frequency of the MM genotype is .60 and the frequency of the N allele is .43.
E. The frequency of the MM genotype is .54 and the frequency of the N allele is .46.

10. Fill in the blanks.

A(n) _____ is an endonuclease that cleaves duplex DNA at specific sites, creating a free 3' _____ group and a free 5'_____ group. The enzyme that covalently joins cleaved DNA segments to form recombinant DNA molecules is _____.

A. DNAse, hydroxyl, phosphate, polymerase
B. restriction enzyme, phosphate, amino, ligase
C. exonuclease, phosphate, hydroxyl, transposase
D. restriction enzyme, hydroxyl, phosphate, ligase
E. restriction enzyme, phosphate, hydroxyl, ligase

11. Which one of the following statements is FALSE?

A. Introduction of a wild-type version of a gene to complement a mutant phenotype is called gene therapy in humans.
B. Genetically modified (GM) foods are basically transgenic plants or animals.
C. Cloning of the bovine growth hormone gene was unnecessary since the goal was to make recombinant bovine growth hormone in eukaryotic cells for injection into cows.
D. The technique to look for possible gene function by mutating wildtype genes is called reverse genetics.
E. Gene targeting is the procedure for introducing changes into specific genes.

ID # _____

12. Esmé is trying to identify how many copies of an SSR are in her genome relative to her brother's genome. She performs the following steps:

1. isolate DNA
2. digest DNA with a restriction enzyme
3. separate the DNA on a gel
4. transfer the gel to a membrane/Southern blot

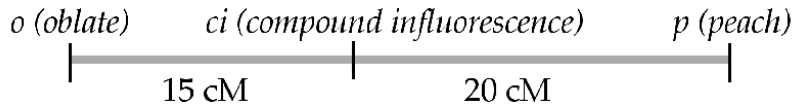
But when she gets to the last step, she is unsure of how to proceed. Choose the best next step from the following:

A. PCR amplify using SSR-specific primers
B. ligate the DNA into a vector
C. hybridize a probe homologous to the SSR
D. hybridize a probe that is homologous to the region directly adjacent to the SSR
E. Stain using ethidium bromide

13. Which one of the following statements is TRUE?

A. Ionizing radiation damages DNA by depurinating the DNA.
B. Deamination of 5-Methylcytosine is more likely to cause a mutation than deamination of Cytosine.
C. Mutagens all damage DNA in the same way.
D. If a chemical is negative in the Ames test it is mutagenic.
E. Mutagens are not harmful when ingested because they are broken down in the stomach.

14. A portion of the linkage map of chromosome 2 in the tomato is illustrated here. The oblate phenotype has flattened fruit, peach results in hairy fruit (like a peach), and compound inflorescence means clustered flowers.



Interference across this region is 80%. Of 1000 gametes, how many of the double recombinant class will be observed?

A. 6
B. 24
C. 30
D. 240
E. 60

15. The factor that converts an F- cell to an F+ cell is a(n)

A. phage
B. plasmid
C. transposon
D. intron

E. virus

16. If in a population in Hardy-Weinberg equilibrium the frequency of homozygous recessive genotype is 0.16, then the frequency of the dominant allele will be

A. 0.026
B. 0.16
C. 0.4
D. 0.6
E. 0.84

17. In a cross between two inbred lines of *Drosophila*, the F_1 progeny has the variance of 0.87 for the number of abdominal bristles. The F_2 generation has the variance of 3.
(I) What is the environmental variance?
(II) What is the broad-sense heritability?

A. (I) 0.87 (II) 0.71
B. (I) 3.0 (II) 0.50
C. (I) 2.13 (II) 0.29
D. (I) 0.87 (II) 0.29
E. (I) 3.0 (II) 0.78

18. Russel the sheep is born with sheep phenylketonuria (PKU, an autosomal recessive disease). At age three, Russel is cloned and the clone is called Russeltoo. At age six, Russel dies of colon cancer.

I. Does Russeltoo have PKU (yes or probably not)?
II. Does Russeltoo get colon cancer (yes or probably not)?

A. I = probably not II = probably not
B. I = yes II = probably not
C. I = probably not II = yes
D. I = yes II = yes

19. Fill in the blanks.
A gene that encodes a protein required to relay a signal telling a non-dividing cell to divide is likely to be a _____. A gene that encodes a protein that actively blocks apoptosis in an unhealthy cell is likely to be _____.

A. tumor-suppressor gene; oncogene
B. oncogene; oncogene
C. tumor-suppressor gene; tumor-suppressor gene
D. oncogene; tumor-suppressor gene
E. malignant; Rb

20. Which one of the following statements is TRUE?
    A. Development of humans is very comparable to the genetic model organism, *C. elegans*.
    B. Morphogens are maintained in a few discreet compartments in the developing embryo.
    C. Development of an organism occurs because cells in different tissues have different genomes.
    D. Homeotic genes are found in gradients produced along the anterior-posterior axis.
    E. Transcription factors are the driving force of development.

21. Spontaneous base substitutions are
    A. biased in favor of transversions.
    B. biased in favor of transitions.
    C. unbiased (transversions and transitions are equally frequent).
    D. silent in most of the cases.
    E. never observed.

22. Osgood's syndrome is an inborn error of metabolism caused by an autosomal recessive gene. The frequency of this allele in the population is 0.03. Assuming Hardy-Weinberg equilibrium, what is the expected incidence of Osgood's syndrome among the offspring of all matings in which both parents are found to be carriers?
    A. 0.0009
    B. 0.03
    C. 0.25
    D. 0.5
    E. 0.0145

23. If a population is NOT at Hardy-Weinberg equilibrium (and you don't know why it is not at HW equilibrium)...
    (I) can you calculate the genotype frequencies if you know the allele frequencies?
    (II) can you calculate the allele frequencies if you know the genotype frequencies?

    A. (I) = yes (II) = no
    B. (I) = yes (II) = yes
    C. (I) = yes (II) = only if there is no inbreeding
    D. (I) = no (II) = no
    E. (I) = no (II) = yes

A

ID # _____

SHORT ANSWER SECTION: Answer in the boxes or indicated spaces provided for each question. Only answers in the boxes or indicated spaces will be graded.
DECIMAL ANSWERS MUST BE TO TWO DECIMAL PLACES AND FOLLOW CONVENTIONAL RULES FOR ROUNDING (4 rounds down, 5 rounds up).

Points are indicated for each question.

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24. In corn plants, the Red and Green genes are 68cM apart. What recombination frequency would you observe between R and G in the following two-point cross? 0.5 PT

$$\frac{RG}{rg} \times \frac{rg}{rg}$$

50 %

25. Below is shown the wild type coding strand for an open reading frame encoding a short protein. Also shown are 4 mutant alleles of this gene. 2.5 PTS
.5 pts each
no partial credit

ATG AAA CCC CCC ATG AAA TAA	wild-type sequence	
ATG TAA CCC CCC ATG AAA TAA	mutant allele I	nonsense
ATG AAC CCC CCA TGA AAT AA	mutant allele II	frameshift — Deletion accepted
ATG AAA CCC CCC CCC ATG AAA TAA	mutant allele III	repl'n slippage
ATG AAA CCC CCC AAG AAA TAA	mutant allele IV	missense
ATG AAA CCC CCC ATG AAG TAA	mutant allele V	silent

hypomorphic and hypermorphic NOT CORRECT because you don't have functional information.

ID # _____

26. You are studying three populations of *Arabidopsis*, UR, GD and SA. The genotype frequencies you find for one locus are shown below: 1 PT

	B1960 locus		
Population	**BB**	**Bb**	**bb**
UR POPULATION	0.40	0.20	0.40
SA POPULATION	0.49	0.42	0.09
GD POPULATION	0.68	0.31	0.01

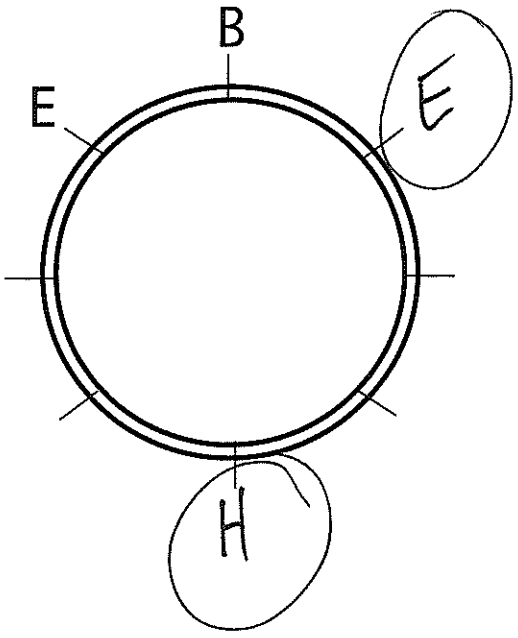
only one correct for each. No partial

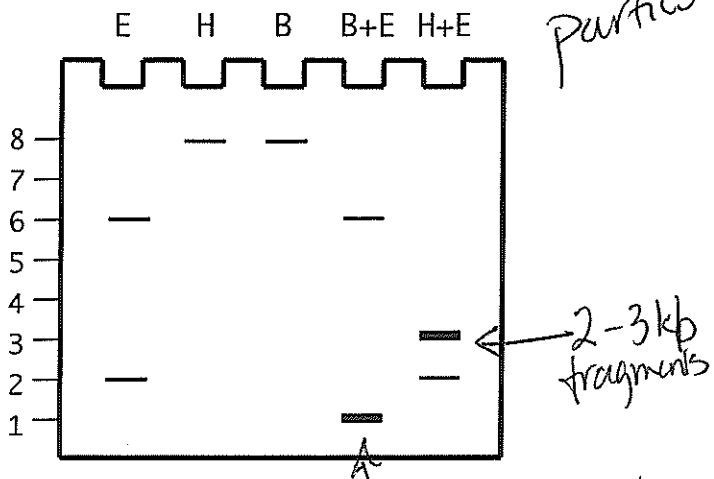
Which population(s) is/are in Hardy-Weinberg equilibrium? SA 0.5 pts

Which population(s) show(s) the affects of inbreeding? UR 0.5 pts

27. You have asked Toby to digest an 8 kb plasmid with the restriction endonucleases EcoRI, BamHI and HindIII. He runs the resulting fragments on a gel and shows the gel to you. **Fill in the necessary sites on the plasmid** that are consistent with the gel Toby has shown you. E = EcoRI, H = HindIII, B = BamHI. The plasmid has been divided into 1 kb increments for you and two sites are indicated as starting points for you. 1 PT

no partial



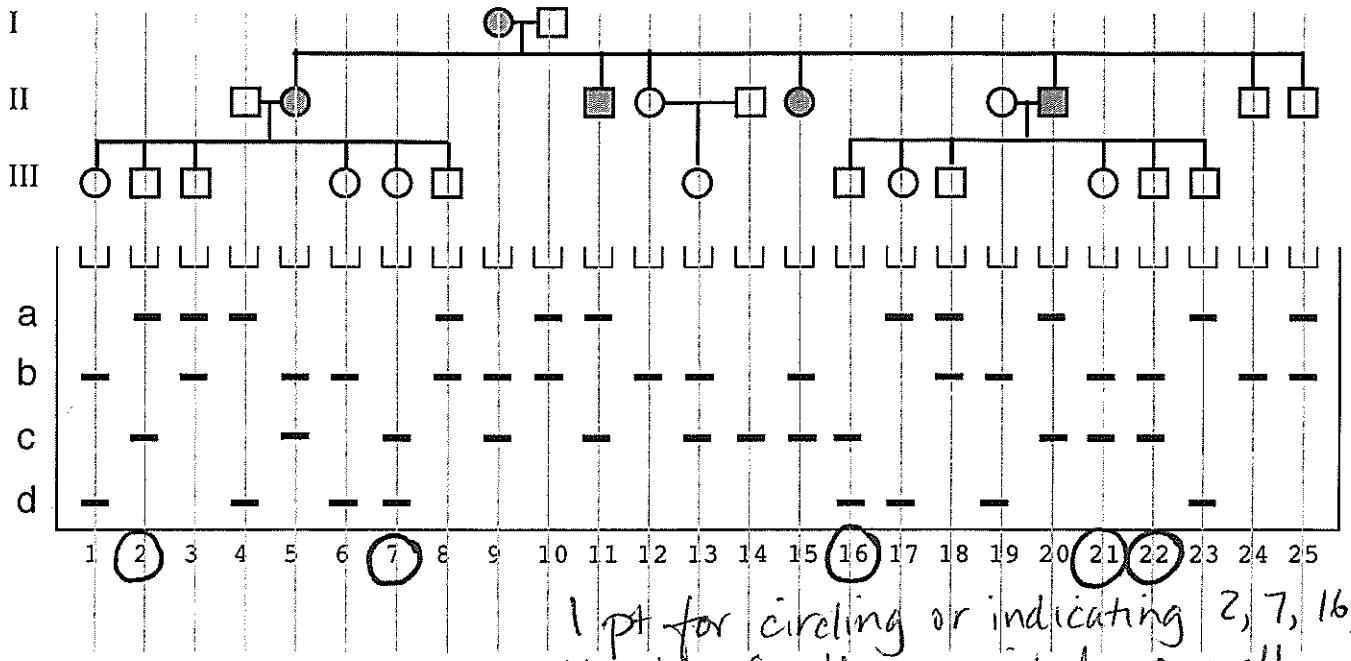


They must add up to 8Kb!

ID # _____

28. The accompanying pedigree includes individuals affected with adenomatous polyposis, a form of colon cancer (gray). The diagram of the gel shows a restriction fragment (RFLP) analysis of *APC* alleles, mutant forms of which are associated with this cancer. *APC* is a tumor suppressor. Four sizes of RFLPs are observed. Individuals in generations I and II are old enough to have developed the cancer if they carry a mutant *APC* allele, but the individuals in generation III are all too young to have developed the disease.

Identify those in **generation III** that are at risk to develop cancer and **<u>circle their individual numbers</u>** (only for generation III) given below the gel.
4 PTS



1pt

1 pt for circling or indicating 2, 7, 16, 21, 2
No pts if others circled as well

If you isolated the genomic DNA from a tumor removed from female "5" and did the same analysis, you might discover that the tumor had only one band. Which band would be remaining, a, b, c or d?

* Good Job on this question! 1.5 pt **C**

What principle is this an example of?

* This proved difficult for students and very few got this correct.

loss of heterozygosity (LOH)
1.5 pt

No partial

ID # _____

29. The ability to taste MSG is controlled by a dominant X-linked allele. In a population in San Diego, 1250 males could taste the compound and 540 could not. What is the percentage of females in the population that are heterozygous for this locus? Assume this population is in H-W equilibrium since mates are not chosen based on this phenotype, nor is there selection for or against this allele. 2 PTS

$q = \frac{540}{1790} = .30$

$p = .70$

$2(.7)(.3) = .42$

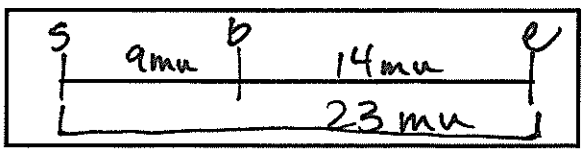
42 %

No partial credit

30. Two-point testcrosses (BS/bs X bs/bs and Be/bE X be/be) revealed the following map results: 3 PTS

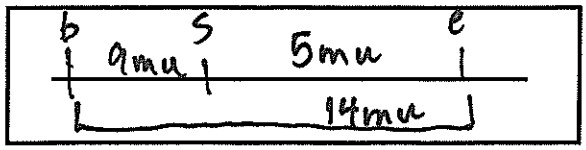
The distance between *b* and *s* is 9 map units
The distance between *b* and *e* is 14 map units

Draw both possible maps, indicating genes and map units, for this region using the lines in the boxes below.



1pt

OR



1pt (2 out of 3 distances must be indicated)

What cross would resolve the two possible maps?

$\frac{Se}{sE} \times \frac{se}{se}$ + ~~#~~ $\frac{Se}{SEB} \times \frac{seb}{seb}$

1pt

OR $\frac{SE}{se}$ $\frac{sEb}{SeB}$

B/E first

✱ 1pt for each map and 1pt for 2-pt ~~cross~~ cross between S & E or a 3 pt cross between B, S & E. (order unimportant)

ID # _____

31. Two normal-looking *Drosophila* are crossed and yield the following phenotypes among their progeny: 4 PTS

Females:	+ + +	2000
Males:	+ + +	3
	a b c	1
	+ b c	839
	a + +	825
	a b +	86
	+ + c	90
	a + c	81
	+ b +	75
	Total	4000

*The hard part was recognizing that the male was $\frac{+++}{Y}$ (normal-looking).

*For calc's, divide by 2000 - only looking at males. (The females genotype will be the same as males, but masked by wild-type alleles.)

What are the parental genotypes for this cross?

male $\frac{+++}{-}$ 1pt

female $\frac{+bc}{a++}$ 1pt

Which gene is in the middle of the map? a 1pt

Most students got this

What is the interference in this region? .71 1pt

Most students got this too! .72 accepted

a-b $86+90+3+1 = 180/2000 = .09$

a-c $81+75+3+1 = 160/2000 = .08$

$(2000)(.09)(.08) = 14.4$ $cc = \frac{4}{14} = .29$ (or .28) $i = 1-.29$ $i = .71$ (or .72)

ID # _____

32. You have been given the task in your Bio199 research lab to determine whether the autosomal *Drosophila* genes *bl* and *vg* are linked. 2 PTS

bl = black body, recessive
bl+ = gray body
vg = small wings, recessive
vg+ = normal wings

No partial

The testcross of an F1 female that is heterozygous for both loci yielded the following numbers of progeny:

429 normal wings, black body
432 small wings, gray body
68 normal wings, gray body
71 small wings, black body

In the double heterozygote F1 female, were the recessive alleles in *cis* or *trans*? 1pt

.5pt trans

Indicate the genotype of this F1 female, using correct nomenclature. 1pt

.5pt $\frac{vg+\ bl}{vg\ bl+}$

Indicate the genotype of the testcross male, using correct nomenclature. 1pt

.5pt $\frac{vg\ bl}{vg\ bl}$

What is the map distance, in map units, between the *vg* and *bl* loci? 1pt

$68+71/1000 = .139 = 13.9$ mu. .5pt 13.9 mu

or 14 accepted.

* Great Job on this question!

ID # _____

.5pts each.

33. Imagine that you observed the following mutants in *Drosophila*: 2 PTS

Homozygotes have very short abdomens which are missing segments A2 through A4.	B .5
Homozygotes have shortened thoracic regions and lack the second and third pair of legs.	B .5
Affected flies have wings growing out of their heads in place of eyes.	C .5
Homozygous females are normal but produce larvae that have a tail at each end and no head ends.	A .5

Based on the characteristics given, assign each of the mutants to one of the categories (write the letter of the category into the table above).

A. Maternal effect gene such as bicoid and nanos
B. Segmentation gene
C. Homeotic gene