ANSWERS TO GENETICS PROBLEMS (#1-12):
(Work follows on next several pages)

1. Genotypic ratio: GG: Gg = 2:2 or 2/4: 2/4 or 50%: 50%
   Phenotypic ratio: 4/4 or 100% green

2. Genotypic ratio: LL: Ll: ll = 1:2:1 or 1/4: 2/4: 1/4 or 25%: 50%: 25%
   Phenotypic ratio: long: short = 3:1 or 3/4 : 1/4 or 75%: 25%

3. F1 generation:
   Genotypic ratio: 4/4 or 100% Tt
   Phenotypic ratio: 4/4 or 100% tall

   F2 generation:
   Genotypic ratio: TT: Tt: tt = 1:2:1 or 1/4: 2/4: 1/4 or 25%: 50%: 25%
   Phenotypic ratio: tall:dwarf = 3:1 or 3/4 : 1/4 or 75%: 25%

   F1 x Tall parent
   Genotypic ratio: TT: Tt: = 2:2 or 2/4: 2/4 or 50%: 50%
   Phenotypic ratio: 100% tall

   F1 x Dwarf parent
   Genotypic ratio: Tt: tt = 2:2 or 2/4: 2/4 or 50%: 50%
   Phenotypic ratio: Tall: Dwarf: 2:2 or 2/4: 2/4 or 50%: 50%

4. Bull is Pp
   Cow A is pp
   Cow B is pp
   Cow C is Pp

   Bull x Cow A
   Offspring would be expected to be 50% polled (like their first calf) and 50% horned

   Bull x Cow B
   Offspring would be expected to be 50% polled and 50% horned (like their first calf)

   Bull x Cow C
   Offspring would be expected to be 75% polled and 25% horned (like their first calf)
   5 c
   6. a, d, g
   7. b, d, b
   8. d
   9. d, a, d

DETAILED ANSWERS TO GENETICS PROBLEMS.

1. Let G = green and g = yellow.

   Homozygous dominant = GG
   Heterozygous = Gg

	G	G
G	GG	GG
g	Gg	Gg

   Genotypic ratio: GG: Gg = 2:2 or 2/4: 2/4 or 50%: 50%
   Phenotypic ratio: 4/4 or 100% green

2. Let L = long and l = short.

   Heterozygous long podded = Ll
   (Ll x Ll)

	L	l
L	LL	Ll
l	Ll	ll

   Genotypic ratio: LL: Ll: ll = 1:2:1 or 1/4: 2/4: 1/4 or 25%: 50%: 25%
   Phenotypic ratio: long: short = 3:1 or 3/4 : 1/4 or 75%: 25%

3. Let T = tall and t = dwarf.
   Homozygous for tall = TT
   Homozygous for dwarf = tt

   Punnett square for F1 generation (i.e., progeny derived from crossing two parents)

	T	T
t	Tt	Tt
t	Tt	Tt

   Genotypic ratio: 4/4 or 100% Tt
   Phenotypic ratio: 4/4 or 100% tall

Punnett square for F2 generation (i.e., progeny derived from crossing two F1s)

	T	t
T	TT	Tt
t	Tt	tt

Genotypic ratio: TT: Tt: tt = 1:2:1 or 1/4: 2/4: 1/4 or 25%: 50%: 25%
Phenotypic ratio: tall:dwarf = 3:1 or 3/4 : 1/4 or 75%: 25%

Punnett square for F1 x Tall parent (Tt x TT)

	T	T
T	TT	TT
t	Tt	Tt

Genotypic ratio: TT: Tt: = 2:2 or 2/4: 2/4 or 50%: 50%
Phenotypic ratio: 100% tall

Punnett square for F1 x Dwarf parent (Tt x tt)

	t	t
T	Tt	Tt
t	tt	tt

Genotypic ratio: Tt: tt = 2:2 or 2/4: 2/4 or 50%: 50%
Phenotypic ratio: Tall: Dwarf: 2:2 or 2/4: 2/4 or 50%: 50%

7. Let P = polled (hornless) and p = horned.
Bull is polled, therefore, based on his phenotype he must have a least one dominant allele (P ____).
Cow A is horned; she must be pp.
Cow B is horned; she must be pp also.
Cow C is polled; like the bull she must at least one dominant allele (P ____)

Cow B's calf with this bull allows us to determine his genotype. The calf is horned and therefore must have the genotype pp. The only way this is possible is if the calf inherits a "p" from both parents. Consequently the bull's genotype must be heterozygous (Pp).

Similarly Cow C's calf sired by this bull allows us to determine her genotype with certainty. The calf is horned and therefore must have the genotype pp. The only way this is possible is if the calf inherits a "p" from both parents. Consequently, like the bull, Cow C must have the heterozygous genotype (Pp). If she was PP she would be polled but she also could only have polled calves.

Punnett Squares for three combinations of bull with cows.

Cow A x Bull: pp x Pp

	p	p
P	Pp	Pp
p	pp	pp

Offspring would be expected to be 50% polled (like their first calf) and 50% horned

Cow B x Bull: pp x Pp

	p	p
P	Pp	Pp
p	pp	pp

Offspring would be expected to be 50% polled and 50% horned (like their first calf)

Cow C x Bull: Pp x Pp

	P	p
P	PP	Pp
p	Pp	pp

Offspring would be expected to be 75% polled and 25% horned (like their first calf)

5. Let S = smooth texture and s = wrinkled texture.

Smooth plant must have a least one dominant allele. Could be either SS or Ss
Wrinkled textured plant must be ss.

Let's do Punnett squares for the two possibilities for the smooth parent and see which one gives a 1:1 ratio of textures in the offspring.

SS x ss

	S	S
s	Ss	Ss
s	Ss	Ss

This would yield all smooth textured progeny.

Ss x ss

	S	S
s	Ss	ss
s	Ss	ss

This would yield a 1:1 ratio of the two textures and consequently the smooth textured plant most likely has the heterozygous genotype (Choice "c")

6. Let F = normal and f = cystic fibrosis.

   Woman who is a carrier for disease = Ff
   Man who is normal and not a carrier = FF

   Ff x FF

	F	F
F	FF	FF
f	Ff	Ff

What percent of children would be expected to have disease? a. 0%
What percent of children would be expected to be carriers? d. 50%
What percent of children would be expected to be normal? g. 100%

7. Let F = normal and f = cystic fibrosis.

   Both parents are carriers = Ff

   Ff x Ff

	F	f
F	FF	Ff
f	Ff	ff

What percent of children would be expected to have disease (ff)? b. 25%
What percent of children would be expected to be carriers (i.e., Ff)? d. 50%
What percent of children would be expected to be homozygous normal (FF)? b. 25%

8. Let G = glaucoma and g = normal

Normal woman must have genotype gg
Man afflicted with glaucoma must have at least one dominant allele (G ___) ; since his father was normal (gg), he could only have inherited a "g" from his father. Therefore, this man's genotype must be Gg.

Gg x gg

	G	g
g	Gg	gg
g	Gg	gg

What percent of children would be expected to have glaucoma (ff)? d. 50%

9. Since this is a sex-linked trait, we must include the sex chromosomes is our nomenclature. Let X^H = normal and X^h = hemophilia.

A woman who is a carrier must have two X chromosomes (to be female) and have one dominant and one recessive allele to be considered a carrier. (X^HX^h)
Her husband must have an X and a Y (to be a male). Since he does not have hemophilia, his genotype must be (X^HY).

X^HX^h x X^HY

	X^H	X^h
XH	XHXH	XHXh
Y	XHY	XhY

What percent of sons would be expected to have disease? d. 50%
(Since the question is about the proportion of the **SONS**, you must look only at the applicable row (or column) of the table. This table shows the boys in the second row. 1 out of 2 or 50% would be expected to be afflicted. If you selected 25%, you are calculating odds of ALL the children having the disease rather than doing a gender-specific analysis). .

What percent of daughters would be expected to have disease? a. 0%
(Since the question is about the proportion of the **DAUGHTERS**, you must look only at the row (or column) of the table showing the girls. This table shows the daughters in the first row. Having inherited the normal X chromosome from their father, 0 out of 2 or 0% would be expected to be afflicted. If your answer was 25%, you are calculating odds of ALL the children having the disease rather than doing a gender-specific analysis). .

What percent of daughters would be expected to be carriers? d. 50%
(Since the question is about the proportion of the **DAUGHTERS**, you must look only at the applicable row (or column) of the table. This table shows the girls in the first row. 50% of the daughter have the carrier genotype of X^HX^h.

If the questions were about this couple's children in general, then we would look at the whole Punnett square: 25% of all children would be expected to have the disease and 25% would be expected to be carriers (Remember even though the son with the genotype X^hY carries the recessive allele, he is <u>not</u> classified as a carrier because he has the symptoms. The recessive allele is not being "masked" in his case).

10. Let R=roller, r= non-roller; E=free ear lobes, e= attached ear lobes.

Man is a non-roller with free earlobes. Based on this we know he must be rr and E__. However we are also told his mother had attached earlobes (ee). Since he inherited one allele from his mother (and it wasn't the E we already know he has), his genotype for earlobes must be Ee.

His wife has attached earlobes and can roll her tongue. Based on this we know she must be R__ and ee. Since her father was a non-roller (rr), she must be Rr.

So this couple is rrEe x Rree. We'll do a Punnett Square for each trait and see what combinations of characteristics we may see in the offspring.

	R	r
r	Rr (roller)	rr (non-roller)
r	Rr (roller)	rr (non-roller)

	e	e
E	Ee (free)	Ee (free)
e	ee (attached)	ee (attached)

Possible phenotypes of offspring:

- roller with free lobes 2/4 x 2/4 = 4/16 = ¼
- roller with attached lobes 2/4 x 2/4 = 4/16 = ¼
- non-roller with free lobes 2/4 x 2/4 = 4/16 = ¼
- non-roller with attached lobes 2/4 x 2/4 = 4/16 = ¼

So the correct choice is: b – All four possible combinations of tongues and earlobes may be expected in roughly equal frequencey (25% of each).

11.Let F= feathered legs and f=clean legs; A=pea comb and a=single comb

A feathered legged, pea combed rooster has the genotype: F__ A__
Clean legged, pea combed hen has the genotype: ff A__.

If all their chicks are feathered legged (Ff), the rooster is most likely FF. If he was Ff, you'd expect at least a few of their offspring to be clean legged.

If most of their chicks are pea-combed but there are some single combed chicks, then the parents must both be Aa. If either (or both) were AA, it would be impossible for them to produce single combed chicks.

Here are the Punnett Squares for these two parents: rooster FFAa x hen ffAa

	F	F
f	Ff (feathered)	Ff (feathered)
f	Ff (feathered)	Ff (feathered)

	A	a
A	AA (pea comb)	Aa (pea comb)
a	Aa (pea comb)	aa (single comb)

Progeny: feathered legs, pea comb = 4/4 x 3/4 = 12/16 =3/4
feathered legs, single comb = 4/4 x 1/4 = 4/16 =1/4
clean legs, pea comb = 0/4 x 3/4 = 0
clean legs, single comb = 0/4 x 1/4 = 0

This is consistent with the offspring described in the problem.

Crossing hen ffAa with one of her offspring that is feather legged and single combed (Ffaa – see Punnett square above) , would yield the following

	F	f
f	Ff (feathered)	ff (clean)
f	Ff (feathered)	ff (clean)

	a	a
A	Aa (pea comb)	aa (single comb)
a	Aa (pea comb)	aa (single comb)

Progeny: feathered legs, pea comb = 2/4 x 2/4 = 4/16 =1/4
feathered legs, single comb = 2/4 x 2/4 = 4/16 =1/4
clean legs, pea comb = 2/4 x 2/4 = 4/16 =1/4
clean legs, single comb = 2/4 x 2/4 = 4/16 =1/4

12. Let H=tall, h=dwarf (h for height) and T = smooth, t = wrinkled (t for texture). Heterozygous parents: HhTt x HhTt

	H	h
H	HH (tall)	Hh (tall)
h	Hh (tall)	hh (dwarf)

	T	t
T	TT (smooth)	Tt (smooth)
t	Tt (smooth)	tt (wrinkled)

Chances of a dwarf plant with wrinkled seeds: ¼ x ¼ =1/16

If there are 80 offspring, you'd expect 1/16 of them or 5 (choice b) to have this phenotype.

Chances of a tall plant with wrinkled seeds: ¾ x ¼ =3/16
If there are 80 offspring, you'd expect 3/16 of them or 15 (choice c) to have this phenotype.