1. (5 pts.) Examine the pedigree shown above. For each mode of inheritance listed below indicate:
E = this mode of inheritance is excluded by the data
C = this mode of inheritance is consistent with the data

_C___ Autosomal recessive inheritance. ARC: recessive allele is **very common** in the population
_**E**_ Autosomal Recessive inheritance ARR: recessive allele is **extremely rare**
would need too many hets from outside family
_C___ X-linked recessive inheritance XRC: recessive allele is **very common**
_**E**_ X-linked recessive inheritance XRR: recessive allele is **extremely rare**
would need too many hets from outside family
_**E**_ X-linked dominant inheritance XD: dominant allele is **very common**
affected sons have unaffected mothers & not all daughters of affected males are affected
_C___ Autosomal dominant inheritance AD: dominant allele is **extremely rare**
_**E**_ Y-linked (gene is on differential region of the Y chromosome) Y
not all sons of affected males show the trait

• For each mode of inheritance that you excluded, circle the portion of the pedigree that excluded this inheritance pattern and label with the appropriate acronym (indicated by letters in bold).
• Note, you do not need to explain why the region of the pedigree excludes the mode of inheritance-- just circle and label it.
• If more than one region of the pedigree excludes a particular mode of inheritance, just indicate one region.
• Be as **precise as possible** when indicating the portion of the pedigree that is relevant. You will not get credit for your answer if you have not correctly completed the pedigree portion of the question
2. (6 pts) See pedigree on page 2 of the extra sheet
This pedigree shows the inheritance in an extended family group of an autosomal recessive trait. For each of these calculations, show your work and circle your answer. To get full credit, you must show how you arrived at your answer. You must tell me the identity of each fraction. I will also look at how you have assigned genotypes on the extra sheet, but your complete calculations must be on this sheet.

a. 3pts What is the probability that both the prospective groom and the prospective bride are heterozygous? In doing this calculation, assume the the bride’s dad is homozygous for the dominant allele.
A = normal allele  a= recessive allele
Since the groom’s mom shows the trait, he must be heterozygous for the recessive allele. Since the bride has an affected aunt (groom’s mom) and an affected uncle, then her phenotypically normal mom has a 2/3 chance of being heterozygous.

P (groom is Aa) = 1
P (bride is Aa) = 1/3   [ 2/3 (mom is het) X ½ (mom passes recessive allele]

OVERALL probability that both are het = 1X 1/3 = 1/3

b. 1 pt The prospective groom’s father is not keen on this marriage. The groom argues with his father about it and says that it is unlikely that both he and his prospective bride are heterozygous for this trait. Calculate the probability that they are not both heterozygous

1-[1/3 (prob both het)] = 2/3 (prob NOT both het)
Since the groom must be Aa, then the probability they are not both het is the same as the probability that the bride is not het which is 1-1/3 = 2/3.

c. 2 pts The father of the prospective groom argues that the son should pick a mate from the population at large. If the frequency of heterozygotes in the population at large is 0.1%, what is the probability that the first child will be affected if the prospective groom follows his father’s advice? Just set up the answer.
P (groom is Aa) = 1  P (bride is Aa) = 1/1000  P both transmit a allele = ¼
OVERALL = 1 X 1/1000 X ¼ = 1/4000
3. (4 pts.) A friend of yours is heterozygous for a dominant allele of a simple Mendelian trait. His wife is homozygous for the recessive allele. They are planning to have a large family -- 10 kids. You are sitting around with them and speculating about the possible outcomes -- how many (and in what order) they will produce phenotypically dominant [D] or recessive [R] kids. Your friend argues that it is much more likely that they will produce a brood of kids that are DRRDRDDDRDR (left to right indicates birth order) than they will produce a brood of all recessive kids: RRRRRRRRRR. In other words, the former possibility is more likely than the latter.

a. Do you agree with their assessment? Circle Yes or No.
Defend your answer with a calculation and a one sentence explanation:

D = dominant allele  d = recessive allele
Cross Dd X dd
Since the birth order is specified, the probability of first outcome is exactly the same as the probability of the second outcome $1/2^{10}$.

b. Speculate as to what your friend was thinking when he made his statement (in italics) to you. One – two sentences maximum

BEST ANSWER:
He was probably thinking about the outcome of 5 phenotypically recessive and 5 phenotypically dominant kids in any birth order. And the probability of this outcome would be greater than all R or all D because of all the different possible birth order scenarios.

CREDIT also given for these answers:
Since the probability of a D or R phenotype for each kid is 50:50, my friend mistakenly thought that he should see this ratio even in a small sample size

My friend mistakenly thought that the outcome of one event (whether a sibling was D or R) influenced the outcome of a subsequent event (the phenotype of other siblings)
4. (5 pts) For the Komodo Dragon, 2n=40 and sex determination is ZZ, ZW. All known viable offspring from parthenogenic reproduction in this species are diploid males.

(i). 1pt each By each statement circle True/False/Not addressed in the Komodo dragon paper. Answer false if any part of the statement is false.

True  Reproduction in Komodo dragons is plastic in the sense that females can switch back and forth between parthenogenesis and normal sexual reproduction.

True  The authors speculate that parthenogenesis is adaptive because a single unfertilized female could found a colony by mating with her parthenogenetic offspring.

(ii) 3 pts We do not know exactly what type of abnormal event produced the parthenogenetic offspring. One formal possibility is the fusion of two cells from two different Meiosis II cell divisions. Assuming that the fusion of these cells occurs at random within a large pool of meiotic II products (present in the ovary of the mother), what would the sex ratio of the viable parthenogenic progeny be? Think carefully about this question before you answer. Show your logic/work. [HINT: this explanation is not consistent with the observation that all parthenogenic offspring were male.]

From the chart on the extra sheet note that komodo dragon females are ZW and males are ZZ. Like in XY males, ZW females will produce two classes of gametes: ½ will have the Z chromosome and ½ will have the W chromosome. If these gametes combine at random, ¼ of the zygotes will be ZZ, ½ ZW and ¼ WW. The WW zygotes will not be viable since all of the Z chromosome genes will be missing from the genome. Since the condition of viability was placed on the outcome, 2/3 of the progeny will be viable ZW females and 1/3 ZZ males.
Autosomal Recessive
1. trait appears in progeny of unaffected parents
2. the trait breeds true and both sexes are equally affected
3. some degree of inbreeding may be present (rare trait)

Autosomal Dominant
1. affected offspring have at least one affected parent
2. trait is passed directly from affected individual to affected individual
3. two affected individuals may have an unaffected child (that is, the trait may not breed true)
4. both sexes are equally affected

X-linked Recessive
1. all daughters of affected males are carriers; all sons of affected females are affected
2. the phenotype is not transmitted from father to son but rather from father to grandson
3. phenotypic expression is higher in males than in females
4. affected female will have an affected father

X-linked Dominant
1. affected males produce all affected daughters and no affected sons
2. a heterozygous female will transmit the trait to about 1/2 of her sons and about 1/2 of her daughters

<table>
<thead>
<tr>
<th>Organism</th>
<th>Female</th>
<th>Male</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>XX</td>
<td>XY</td>
<td>The X chromosome carries at least 1600 genes; the Y chromosome a couple of hundred.</td>
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<td>Some amphibians and reptiles</td>
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<td>Many insects such as the</td>
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<td>fruitfly <em>Drosophila</em></td>
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<tr>
<td>Birds</td>
<td>ZW</td>
<td>ZZ</td>
<td>The Z chromosomes carries many genes; the W chromosome is analogous to the Y chromosome</td>
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<td>Some insects (such as moths</td>
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<td>and butterflies)</td>
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<td>Some reptiles &amp; amphibians</td>
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<td>including the KOMODO dragon</td>
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<td>Bee, wasps and ants</td>
<td>diploid</td>
<td>haploid</td>
<td>Males develop from unfertilized eggs; females from fertilized eggs Mated females typically produce both male and female progeny</td>
</tr>
</tbody>
</table>