

1.) a.) **6pts.**) The ionic bond is stronger, but it is overcome by the many dipole interactions of the water molecules. There is also higher entropy when the salt is dissolved than when it is in the crystal.

b.) **5 pts** Xenon has electrons further away from its nucleus and more of them, so it is easier for them to create an induced dipole and cause more Van der Waals forces.

c.) **5pts.** The consensus was that the gecko is able to modulate the strength of the Van der Waals forces by changing the angle of its toe. The toe then peels off the surface.

2.) **13pts**

a.)

b.) 41250g/mol

c.)  $3.4m \times 10^{-10} \times 3 \times 375 = 382 \text{ nm}$ . Our DNA is 2m. So all non-exon DNA constitutes:

$$\left( \frac{2m - 23000 \times 382 \times 10^{-9}m}{2m} \right) = 99.56\%$$

3.)

a.) Substitution will only change one amino acid and may only have a marginal effect on the protein, while a deletion is likely to change every amino acid completely destroying the protein. **(7pts)**

b.) Mutations can be helpful by increasing genetic diversity which drives evolution. However, they can also be the cause of many diseases such as cancer. **(7pts)**

c.) Yes, some mutations can neither help nor harm an organism. **(3pts)**

4.) **17pts**

All introns are cut out. An exon is either there or it isn't, giving two possibilities for each exon. Therefore, there are  $2^N$  possibilities. If we follow the example in class and no one exon proteins (or zero exon proteins) are allowed, we are left with  $2^N - 1$ .

In combinatorics, we can have a k out of the n exons present in a protein which gives us:  $\binom{n}{k}$ .

We sum this from k=2 to n, because we should not have any 1 exon or 0 exon proteins:

$$\sum_{k=2}^n \binom{n}{k}$$

Note: it was unclear if there could be 1 exon proteins, so answers with 1 exon proteins are okay too.

5.)

a.)  $2^{23}$  different genotypes. **(4pts)**

b.)  $2^{23} \times 2^{23} = 2^{46}$  **(4pts)**

c.) Crossing over increases the number of genotypes. **(4pts)**

d.) There are  $2^{46}$  different types of genotypes available to offspring with sexual reproduction and only one genotype available for asexual reproduction.

If your environment is changing, it is beneficial to have a diversity of genotypes available in the hopes some will

However, if you are a bacteria and your environment stays constant, it is not beneficial to be innovative, because you can already survive in your current environment. Rather, you should produce many offspring genetically identical to yourself. **(8pts)**

6.) **17pts**

hydrophobic(water-hating and greasy): Phenylalanine, Leucine, in A

hydrophilic(water-loving and non-greasy): Arginine, Tyrosine, Glutamate in B