1.
Runtime of StringStrand: O(Nb + Sb^2)

Theory:
Initializing the variables on lines 19-23 are O(1). The while loop uses .indexOf() - an O(N) operation to loop through every index of the original DNA (this) strand. This while loop executes b times for a total runtime of O(N). The first if statement runs only once, when the first occurrence of enzyme is read in the DNA strand. This operation is O(1). Within the while loop, the .appends - an O(N + bS) operation is called every time the enzyme is located within the original DNA strand and isn't the first occurrence of the enzyme this runs O(b-1). Since this method uses string concatenation, it has to create a new string every time making a total runtime of O(N + bS) Finally, the .append() method runs for every iteration of the while loop which executes every time the enzyme b is present. Thus the final runtime is O(Nb + Sb^2).

Empirical:
This runtime is evident in the empirical data because as N and b are held constant, but S increases, time increases at a low rate. Also, as N and b increase while S stays the same, time increases at a much faster rate evident by the square operation on b.

2.
Runtime of StringBuilder: O(N + bS)

Theory:
The String Builder uses a very similar algorithm as StringStrand, however the .appends method doesn't simply concat onto a new string, but uses the stringBuilder .appends method. This method has a runtime of O(N + Sb). This means a new string isn't created every time the .appends() method executes, but only when the internal array fills which amortizes to O(1). As a result, the total runtime of StringBuilder is O(N + bS) as the amount of times .appends is run is equal to the amount of references to the enzyme in the DNA strand.

Empirical:
The StringBuilder class has the same trends as the string strand class. The one difference is that the String Builder class has greater runtimes throughout the benchmark. This is because the stringBuilder takes advantage of an internal list that allows the String to grow. However, in the extremes, this requires more time as the entire internal list is copied and recreated with the additional characters added to the end.

3.
This would require an additional O(b(N + S)) bytes of storage to add. Because b is the amount of enzymes that are removed and then for each enzyme S bytes are added. This would be different for the StringBuilder class because this class makes use of the StringBuilder .appends() method which makes use of an internal list in order to allow for a growable String. This would use less storage as the internal array list wouldn't need to concat a String, taking up storage to save the full strand with every singular addition of S.

4.
Runtime of LinkStrand: O(N + b)

Theory:
The cutAndSplice method loops through the nodes the length of the DNA strand (N). When a match to the enzyme is found, a new Node is created and added to the linked list. Since the location of the splice

in memory doesn't need to be copied and instead pointed to by the linked list, S has no bearing on the runtime. Thus, runtime is only effected by how many times the DNA strand is broken (b).

Empirical:
The empirical data reflects the runtime O(N + b) because the time only increases with an increase in b and N. A change in S has no effect on the overall timing.

5.
The overall storage of the cutAndSplice operation is O(N + 8b + S). Since S can be pointed to by individual nodes of the linked list, it is only stored in memory once. Then for each enzyme match (b), 8 bytes of storage are used. Finally, the original length of the DNA strand N is stored once

6.
Kary Mullis was a genius. His work on PCR has lead to revolutionary advances in chemistry that have played instrumental roles in our understanding of the human genome. Additionally, his invention of the PCR method has vastly improved the quality and safety of forensic science, greatly improving the techniques of the past. While his genius and accomplishment is undeniable, his mind was also stricken by less favorable views. An obsession with LSD as well as controversial opinions on humanity's role in climate change shed light on an unfortunate reality that the world's greatest minds are often lacking practical sense in other avenues. Mullis was an incredible individual, a perfect representation of the human brains incredibly capability and shortcoming.