Telomeres are sections of repetitive DNA base sequences that serve a number of functions. The following example illustrates the particular series of six-base repeats that is found at both ends of every human and chimpanzee chromosome.

```
... ttaggg ttaggg ttaggg ttaggg ttgggg ttaggg ttaggg
eod of chromosome
... aatcccaatcccaatcccaatcccaatcccaatcccaatcccaatccc
```

We can simplify our view by just examining the top strand.

```
ttaggg ttaggg ttaggg ttaggg ttgggg ttaggg ttaggg
```

Inserting spaces makes the repeating pattern more obvious.

```
ttaggg ttaggg ttaggg ttaggg ttgggg ttaggg ttaggg
```

These telomeric sequences may vary slightly. For example, part of the sequence might look like this:

```
ttaggg ttaggg ttgggg ttaggg ttgggg ttgggg ttgggg
```

The most characteristic feature of a telomere is that one strand has many repeats of 3 or 4 g’s at a time, and virtually no c’s while the opposite strand has many repeats of 3 or 4 c’s at a time and virtually no g’s.

When the telomere of one chromosome attaches to the telomere of another chromosome the strands always “flip” so that when they join the strand dominated by g’s attaches to the strand dominated by c’s as illustrated below.

```
<table>
<thead>
<tr>
<th>gggattg gattg gttgggttgggatt</th>
<th>aatcccaatcccaatcccaatcccaatccc</th>
</tr>
</thead>
<tbody>
<tr>
<td>cccctaaccctaaccctaaccctaacccta</td>
<td>ttaggg ttaggg ttaggg ttaggg</td>
</tr>
</tbody>
</table>
```

Looking at just the upper strand, for simplicity, this is how the telomere to telomere fusion will appear:

```
gggattg gattg gttgggttgggatt aatcccaatcccaatcccaatcccaatccc
```

Fusion location

We can see the resulting pattern more easily by inserting spaces . . .

```
gggatt gggatt ggggtt gggatt aatccc aatccc aatccc aatccc
```

In conclusion – one would expect to see, surrounding a telomere fusion point, a series of many repeats containing 3 or 4 g’s at a time, followed by a switch to many repeats containing 3 or 4 c’s at a time.
Now let's have a closer examination of Human chromosome #2!

As you know, human chromosome 2 is homologous to two separate chimpanzee chromosomes. Biologists have good reason to suspect that this is due to a fusion event that occurred among human ancestors after they diverged from the chimpanzee lineage. In other words, they suspect that the common ancestor to both humans and chimpanzees had a chromosome arrangement similar to that of modern chimps. Later, these two chromosomes fused – the result being the present human chromosome #2.

If this hypothesis is correct we should be able to find DNA sequence evidence to support this claim. We should be able to find a telomere-telomere sequence similar to that above.

Examine figure 1 – showing the location of the suspected fusion.

Your teacher will provide you with a printout or text file of the numbered base sequence of human DNA from this portion of human chromosome #2. You can use the printout or text file to search for evidence of the telomere-telomere fusion.

If and when you find the telomere fusion region, record the index numbers for the beginning, ending, and precise fusion locations.

Start index number: __________________________
End index number: __________________________

Attempt to locate the precise location of the telomere-telomere fusion.

Fusion location: __________________________

[Diagram of Human and Chimpanzee chromosomes with a marked area for chromosome #2]
Telomere-Telomere Fusion Location in Human Chromosome #2

The following 2820 bases is a very small portion of the DNA molecule in human chromosome #2. The bases are arranged in groups of 10 to make it easier to read. The base reference numbers at left can be used to identify any particular base in this sequence. Each number corresponds to the first base in the line. So for example, the bolded “t” in the first line is base number 107253 of this sequence.

Examine this sequence and find the base sequences that are evidence of a telomere to telomere fusion.

107221 atgataccgcgtgctggcaa tctcgtttaa actacatgca ggaacagcga aggaaatccg
107281 gcaattgcggttgctgtgc taacccctaa ctaacaattc tatctcttaa gagaatgggc
107341 aaaaatacac atggccaggc cccagcccaa atcactaata agaatctcca gggcttcacc
107401 atgatccttc gttctcctaa ctaataatcc ccaactctgt gtagaagaa gggccggcca
107461 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
107521 tttttttttta ccaaggtctc cgaggtcaag gggcaaggt tttggtgttc ggggcttcacc
107581 cataatgcttctc atgcggtctgc cccactactg ggtgccccag gcgcctgtgc tttggtgaaa
107641 ggcgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
107701 caaatggctc ggcgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa
107761 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
107821 ctctctgctgc ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
107881 tggaggggtagtactgattc cttctcagtt gtaggaggg ggggggtcct cggggtgcccc
107941 tgtgtgctctc ttttcttggtc gtttaccttg tggaggggtag ggtgccccag gcgcctgtgc
108001 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108061 ggcgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108121 ggcgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108181 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108241 gaaagaaaa gcccctctgta tctctgggcc ggcacgtgta cttctcagtt gtaggaggg ggggggtcct
108301 tggaggggtagtactgattc cttctcagtt gtaggaggg ggggggtcct cggggtgcccc
108361 tggaggggtagtactgattc cttctcagtt gtaggaggg ggggggtcct cggggtgcccc
108421 caggtttggtctcttctgcag cccttctttgcat ctcggctttg ggggggtcct cggggtgcccc
108481 gggggtgcccc ccggggtgcccc gcgcctgtgc tttggtgaaa ggggcttcacc
108541 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108601 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108661 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108721 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108781 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108841 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108901 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
108961 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109021 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109081 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109141 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109201 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109261 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109321 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109381 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109441 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109501 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109561 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109621 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109681 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109741 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109801 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109861 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109921 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc
109981 gttgcctccag cttgcacagcg ccggcggctc ggccccagct tttggtgaaa ggggcttcacc

[Answer: the telomere sequences extend from base 108310 to 109125 with the exact fusion point being located at position 108561/108562]