

# Solutions to Practice Problems for Molecular Biology, Session 4: Alternative Approaches to Molecular Biology

## Question 1

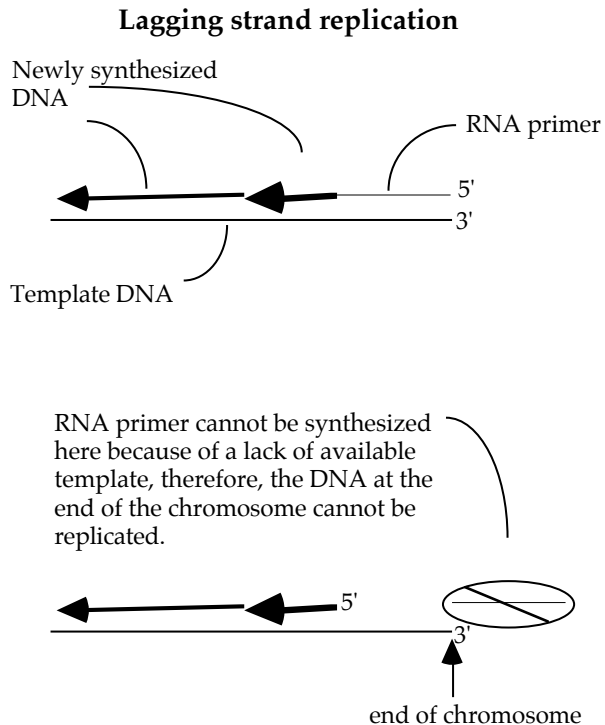
All known DNA polymerases extend DNA chains in the 5' to 3' direction and require a primer. As the fork approaches the end of a linear chromosome, synthesis of the leading strand continues to the end of the DNA template strand, completely replicating the leading strand template. However, the lagging strand template is copied in a discontinuous fashion and cannot be replicated in its entirety.

a) Diagram or describe the lagging strand template and the newly synthesized discontinuous strand at the end of the chromosome.

*The final 3' end of the lagging strand cannot be replicated, because there is no DNA to serve as a template for the RNA primer.*

b) Diagram or describe what will happen to the length of the chromosome upon multiple rounds of replication. Explain why this may have undesirable consequences.

*Since each strand of the starting DNA is used as a template for one copy of the replicated DNA (semi-conservative replication) one copy will be shorter than the other. After many, many rounds of replication, cells with dramatically shorter ends can result.*



c) Some organisms such as bacteria and viruses have circular, not linear, chromosomes. Explain how having a circular chromosome could solve the problem discussed above.

*With a circular chromosome, the DNA is continuous – it has no "end". This means that there will always be DNA from which to make the RNA primer for the lagging strand.*

d) Other organisms have non-coding sequences at the ends of linear chromosomes called telomeres. A telomere is simply a long stretch of repeated nucleotides. Why does the telomere lessen the impact of the incomplete replication of lagging strand templates?

*Telomeric DNA can be replicated by a special enzyme, telomerase. Telomerase carries its own RNA template, and can extend a DNA molecule at the end.*

### Question 2

You are studying a very short protein-encoding region whose sequence is shown below. The region of sequence shown is from the transcriptional start site to the transcriptional stop site. This region encodes two different polypeptides. The region's one small intron is shown for you in bold.

5' -CTACGTACTATGTATTCC**GATCTATA**CTCGATCTAGTTCGCATTCCGATAAGATCGTAC-3'  
3' -GATGCATGATACATAAGG**CTAGATAT**GAGCTAGATCAGCGTAAGGCTATTCTAGCATG-5'

a) What are the sizes of the two polypeptides?

*8 amino acids and 10 amino acids*

b) Which strand is used as a template in transcription for the smaller polypeptide, the upper strand or the lower strand?

*The upper strand of the DNA will serve as a template to produce an mRNA that looks like the bottom strand.*

c) How many nucleotides long would the final processed mRNA made from this gene be (not including the 5' cap and the 3' polyA tail)?

*The final processed mRNA will be 50 nucleotides long.*

d) What is the sequence of the smaller polypeptide

*N met-arg-leu-asp-arg-gly-asn-thr C*

f) Say that the C:G base pair that is underlined in the sequence above were changed to an A:T basepair to make a mutant form of this gene.

i) Which kind of mutation would this be for the smaller polypeptide? Your choices are: a frameshift mutation, a nonsense mutation, a silent mutation, or a missense mutation.

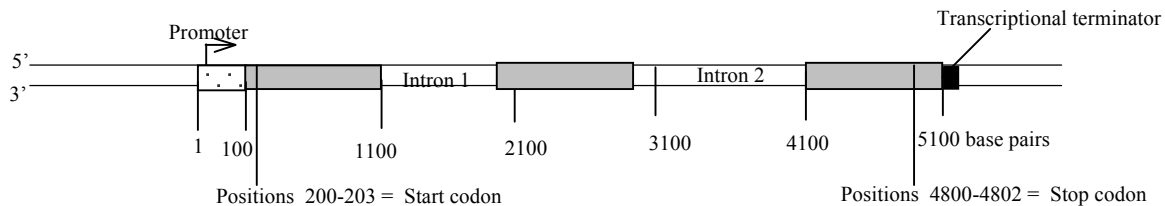
*This is a missense mutation, the codon GAU (asp) is now UAU (tyr).*

ii) Which kind of mutation would this be for the larger polypeptide? Your choices are: a frameshift mutation, a nonsense mutation, a silent mutation, or a missense mutation.

*This is a missense mutation, the codon CUA (leu) is now AUA (ile).*

### Question 3

Below is a schematic of gene Y, which encodes protein Y. The promoter region is indicated by the dotted box. Transcription begins immediately following the promoter.



a) The transcript first produced by this gene would be approximately how many nucleotides long?

*The first transcript produced by this gene would be 5000 nucleotides long.*

b) The transcript from this gene that is used for translation would be approximately how many nucleotides long?

*The mature mRNA produced by this gene (excluding the 5' cap and the 3' polyA tail) would be 3000 nucleotides*

MIT OpenCourseWare  
<http://ocw.mit.edu>

7.01SC Fundamentals of Biology  
Fall 2011

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.