UNIVERSITY MEDICINE • EXERCISE SHEET

# 1.4 Gene expression: transcription and translation

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

**KEY WORDS** splicing

## Objective

Apply codon arithmetic, timing estimates and splice mechanics to expression problems.

## 1 Key knowledge and worked examples

■ **The code**

$4^3 = 64$ codons = 61 sense + 3 stop, for 20 amino acids; degeneracy concentrated at base three. Pol II ~20 nt/s; ribosome ~3 aa/s.

■ **Worked example: one molecule, one minute**

Preproinsulin (110 aa): translation $110/3 \approx 37$ s; its 0.5 kb mRNA transcribed in ~25 s – so secretion pre-builds and stores ✓.

## 2 Practice

**2.1** Why must codons be triplets, not doublets? [3]

**2.2** Translate the timing: a 300 aa protein at 3 aa/s. [3]

**2.3** Why are third-base substitutions often silent? [3]

## 3 Exam-style questions

**3.1** A gene whose pre-mRNA is 4.2 kb, with one 1.8 kb intron removed, leaves a 2.4 kb mature mRNA.

Compute the transcription time at 20 nt/s. Compute the translation time of its 220-codon ORF at 3 aa/s. Explain why several ribosomes (polysomes) translate one mRNA simultaneously, and what this does to protein output per transcript. [8]

**3.2** A (fictional) sequencing case: anaemia, no coding mutation, a new splice donor inside an intron.

Explain the mechanism from new donor site to disease. State what happens to the reading frame if 47 bases are retained. Predict whether a single-base third-position change in an exon would likely cause disease, with a reason. [7]