

Company Resources

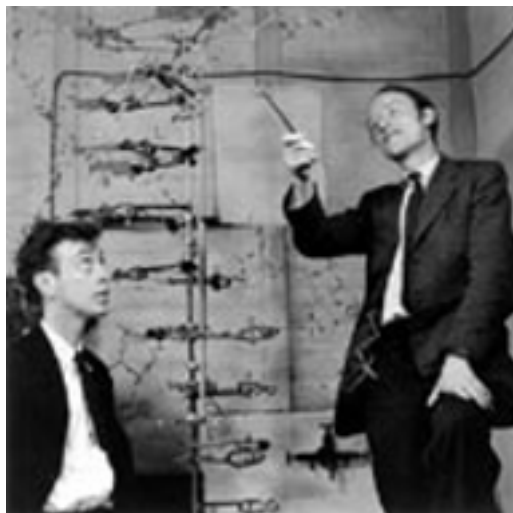
Granby Transcription and Translation Services plc has invested heavily in the Protein Synthesis business. Amongst the resources available to new recruits are:

- ☎ the latest cellphones which Department members can use to request materials and services from one another; and
- 📖 a Library of technical notes which Department members can refer to if necessary.

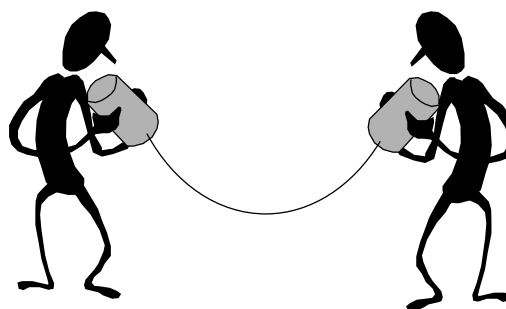
If Departments need additional assistance to synthesize the required protein, the Customer is never far away to provide more detailed information on his or her requirements.

The Customer

It is always important in business to keep the Customer happy. At the moment *Granby Transcription and Translation Services plc.* only have one customer, called **Sir**. He has several proteins that he would like you to make but, realising that you are new to the business will just require tetrapeptides at this stage. As he is anxious to receive the correct products, **Sir** will give technical advice to new recruits on request.



Granby Transcription and Translation Services plc



Granby Transcription and Translation Services plc

DNA Transcribed "While-U-Wait"

No protein too big or too small - you code for it - we'll make it!

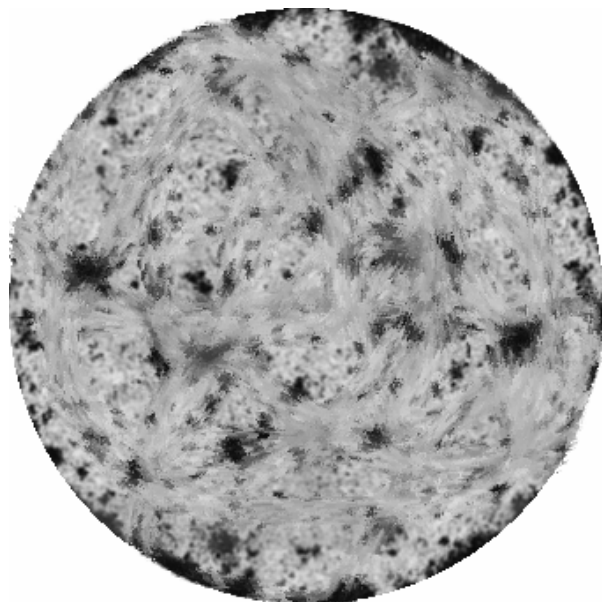
Granby Transcription and Translation Services plc is a very recently formed business: its aim is to take over the protein synthesis monopoly enjoyed by living organisms for over 3 billion years. As new recruits to the business, you will have to prove that you understand the role of all the departments before you can pass your probationary period.

The business itself is divided into two major divisions:

- the *Nucleus Division*, who guard the blueprints and who ship transcribed copies on request; and
- the *Ribosome Division*, who collect the raw materials together and synthesize the proteins.

If you pass your probationary period, your only problem will be fitting inside a cell to carry out your work...

The Nucleus Division



There are two major departments in this division, housed in the same room.

The Archive Department

*“None of **our** genes are worn out or **blue**”*

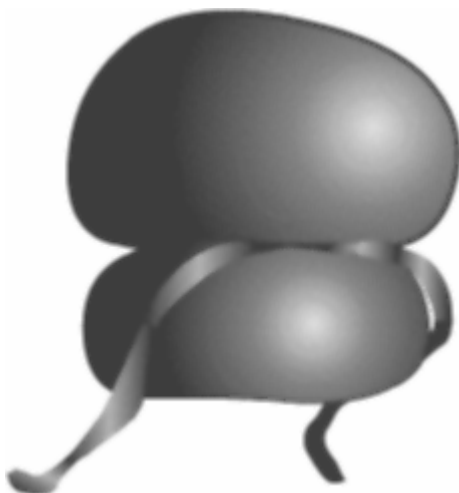
You store and monitor all the data needed to produce proteins required by the cell. Yours is a thankless task: the Human Being Section alone has as many as 10 thousand million base pairs in its archive. You pride yourselves in making available *any* DNA sequence on request from the Transcription Department, complete with instructions on where to start and stop transcribing.

The Transcription Department

“The code is degenerate, not us”

Working closely with the Archive Department, your job is to convert (transcribe) a sequence of genetic code from DNA to mRNA. Each sequence requested from the Archive Department comes complete with instructions on where to start transcribing and where to stop, so you shouldn't go wrong or start working at the wrong end (an unpleasant habit that some lower forms of life are rather pleased with themselves about). You must ship the finished product to the Ribosome Division.

The Ribosome Division



There are two major departments in this division, scattered throughout the building, but who work closely together when required.

The Transfer Department

*“The Anticodons are not aliens from **Star Trek**”*

You have access to a warehouse full of amino acids. These can be bound to the appropriate tRNA molecules by ester bonds. Given a sequence of mRNA bases by the Translation Department, you can identify the corresponding tRNA molecules, and transfer them with the correct amino acids to one of the main ribosome production lines.

The Translation Department

“Proteins R Us”

You are located at one of many ribosome production lines. You have three jobs:

- You read the code supplied on the mRNA by the Transcription Department, and request the correct tRNAs from the Transfer Department.
- You to attach the tRNAs to the mRNA (using energy supplied by the reliable ATP Energy Company).
- You make the protein by forming peptide bonds between the amino acids and breaking the ester bonds holding the amino acids to the tRNAs. You get a little energy back from this, but sadly not enough to repay the ATP Energy Company.

Granby Transcription and Translation Services plc

Department Handbook for the Archive Department

When you receive instructions from the *Translation Department*, locate the correct protein in the library of DNA sequences below.

Send the correct sequence of DNA bases to the *Transcription Department*.

Protein	DNA sequence					
badhairdase	TAC	CCA	CGA	CAT	TAT	ATT
bendotropin	TAC	ATG	AAC	CAA	GTA	ATC
bordgame	TAC	TGT	TAA	CGG	TTG	ATC
dipyourtoin	TAC	GTT	CTC	GTC	CTT	ATT
examinogen	TAC	ACG	AGG	TCA	GGG	ATT
freezin	TAC	ACC	TAC	GGC	TCT	ATT
justestin	TAC	GTG	GCC	AAG	TGT	ATT
lobitinogen	TAC	AAA	AGC	TCA	CCC	ATT
loralaffinase	TAC	GGG	ACG	GCA	TAT	ACT
popsene	TAC	CCC	TGG	TTA	GTC	ATT
refrase	TAC	TAC	CGC	TTT	ACC	ATT

Library of DNA sequences in the customer's genome

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Department Handbook for the Transcription Department

When you receive instructions from the *Archive Department*, use the table below to transcribe the sequence of DNA bases into mRNA.

When complete, send the mRNA sequence to the *Translation Department*.

Base on DNA	Base on mRNA
A	U
G	C
T	A
C	G

DNA → mRNA conversion table

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Department Handbook for the Translation Department

When you receive a protein order from the customer, call the *Archive Department* with your requirements, then wait until you receive notification of the mRNA sequence from the *Transcription Department*.

Convert each codon (group of three bases) in the mRNA sequence to the appropriate anticodon using the table below, then transmit the sequence of anticodons to the *Transfer Department*.

Base on mRNA codon	Base on tRNA anticodon
A	U
G	C
U	A
C	G

Codon → anticodon conversion table

The *Transfer Department* will then send you the correct sequence of amino acids to enable you to synthesise the protein ordered by the Customer.

Ship your completed protein to the customer and wait for further orders.

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Department Handbook for the Transfer Department

When you receive the sequence of anticodons from the *Translation Department*, use the conversion table below to work out corresponding amino acids.

Transmit the sequence of amino acids to the *Translation Department*.

First base	Second base				Third base
	A	G	U	C	
A	phenylalanine	serine	tyrosine	cysteine	A
	phenylalanine	serine	tyrosine	cysteine	G
	leucine	serine	stop	stop	U
	leucine	serine	stop	tryptophan	C
G	leucine	proline	histidine	arginine	A
	leucine	proline	histidine	arginine	G
	leucine	proline	glutamine	arginine	U
	leucine	proline	glutamine	arginine	C
U	isoleucine	threonine	asparagine	serine	A
	isoleucine	threonine	asparagine	serine	G
	isoleucine	threonine	lysine	arginine	U
	methionine/ start	threonine	lysine	arginine	C
C	valine	alanine	aspartic acid	glycine	A
	valine	alanine	aspartic acid	glycine	G
	valine	alanine	glutamic acid	glycine	U
	valine	alanine	glutamic acid	glycine	C

Anticodon → amino acid conversion table

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Orders Received

Protein	amino acid sequence					
badhairdase	start	gly	ala	val	ile	stop
bendotropin	start	tyr	leu	val	his	stop
bordgame	start	thr	ile	ala	asn	stop
dipyourtoin	start	gln	glu	gln	glu	stop
examinogen	start	cys	ser	ser	pro	stop
freezin	start	trp	met	pro	arg	stop
justestin	start	his	arg	phe	thr	stop
lobitinogen	start	phe	ser	ser	arg	stop
loralaffinase	start	pro	cys	arg	ile	stop
popsene	start	gly	thr	asn	gln	stop
refrase	start	met	ala	lys	trp	stop