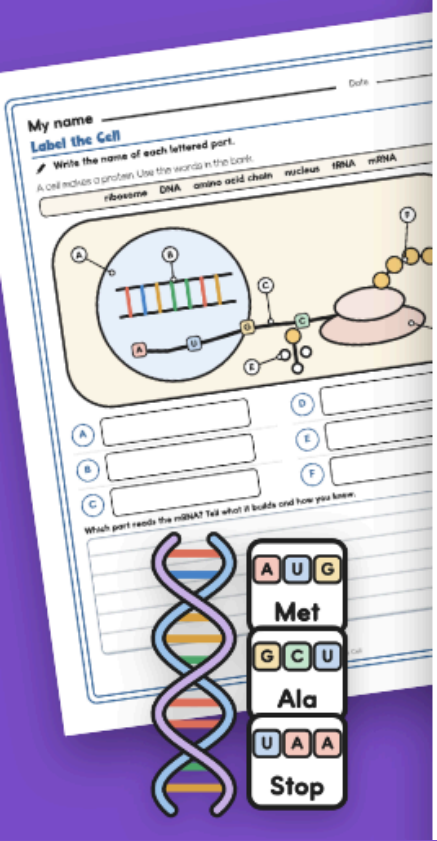
PROTEIN SYNTHESIS

WORKSHEETS
GRADES 8-10

25 STUDENT PAGES



My name _____ Date _____

Translate: mRNA to Amino Acids

Write the amino acid for each codon.

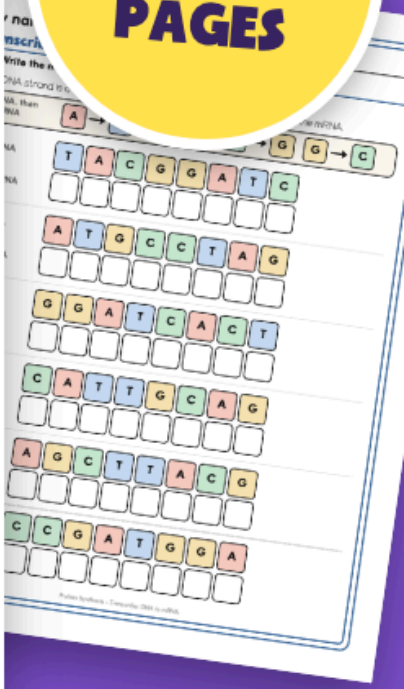
Read each strand one codon at a time. Use the chart. Write the 3-letter name, or Stop.

	U		C		A		G	
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys
	UUA	Leu	UCA	Ser	UAA	Stop	UGA	Stop
	UUG	Leu	UCG	Ser	UAG	Stop	UGG	Trp
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg
	AUG	Met	ACG	Thr	AAG	Lys	AGG	Arg
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly

First base on the left, second base across the top. Green is the start codon. Red is a stop codon.

1	mRNA	AUG	GCU	UUC	GAA	UAA
	amino acid					
2	mRNA	AUG	CCA	AAG	GUU	UGA
	amino acid					
3	mRNA	AUG	CAU	GGC	ACU	UAG
	amino acid					
4	mRNA	AUG	UAU	CGA	GAC	UAA
	amino acid					

Protein Synthesis - Translate: mRNA to Amino Acids



Bright Path Sped

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- The name line, every answer box, every ruled work box and every check box on the student pages are type-in fields, and so are the tracker, class grid, team note and family page. You can also print any page and write by hand.
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Print at 100 percent

Turn off fit to page and shrink to fit so the ruled lines stay 0.34 inch apart. Every student page is black and white inside a colored border, so it still reads when copied in black and white.

Student work

A filled-in tracker, class grid or team note carries a real student's name. Keep it in the data folder, and use a first name only on any page that leaves your hands.

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PREVIEW

How To Read a Page

The parts of a student page, then the kinds of sheet in the order they come.

The parts of a page

- **The answer box.** A bordered box for a letter, a base or a word. Click it to type, or print and write in it.
- **The ruled work box.** Lines 0.34 inch apart for sentences. Write one idea to a line.
- **The check box.** True or false, yes or not yet: click or mark.
- **The word bank.** A box of words to use. Some words are used once, some twice.
- **The cut line.** Twelve pieces in a 4 by 3 grid, edge to edge: two straight cuts across and three down.

Kind of sheet	How many	What the student does
Readings and cards	4 sheets	Read, answer, and keep the process cards to look things up.
Chart, words and compare	5 sheets	Use the codon chart, match words, compare DNA and RNA.
Strands	4 sheets, 19 rows	Each strand row counts as one item: every box in it must be right.
Label and check	4 sheets, 22 items	Label the cell, check sentences, find Noor's mistakes.
Writing	2 sheets, 6 questions	Short answers with four ruled lines each.
Quizzes, exit tickets, sorts	12 items, 3 tickets, 24 pieces	Two quizzes, one exit sheet, two cut-and-paste pages.

Untimed, unscored on the page

No student page has a timer or a score on it. The keys and the tracker are for you. The answer keys are on pages 30 to 35.

Short answers

Their key (page 34) says what to look for, not one right sentence. Accept any answer that uses a fact from the readings or the cards.

Printing and the type-in fields

Every page prints clean in black and white. The name line, every answer box, every ruled box and every check box are type-in fields in any PDF reader: click one, type, then save. This is a fillable PDF, not a slideshow or a word-processor file.

Room to work

Work boxes hold three or more lines. If a student needs more room, hand over one page a day, or let students write on scrap paper and copy their best sentences into the box.

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

Reading 1: Cells Make Proteins

Read about proteins. Then answer.

DNA, genes and proteins

Your cells build proteins all the time. Proteins do many jobs inside cells. The instructions for every protein are stored in **DNA**, a long molecule made of four bases: A, T, C and G. A **gene** is a section of DNA that holds the instructions for one protein. In a cell with a nucleus, the DNA stays inside the **nucleus**. But proteins are built on **ribosomes**, out in the cytoplasm. So the cell makes a copy of the gene, called **messenger RNA (mRNA)**, that can leave the nucleus. A protein is a chain of smaller parts called **amino acids**.

Main idea: What is this reading mostly about?

Check what you read. Write the letter in the box.

1. Where is DNA stored in a cell with a nucleus?
   - **A** In the nucleus
   - **B** On a ribosome
   - **C** In the cell membrane

2. What is a gene?
   - **A** A kind of ribosome
   - **B** A section of DNA with the instructions for one protein
   - **C** A chain of amino acids

3. What is a protein made of?
   - **A** A strand of bases only
   - **B** A copy of mRNA
   - **C** A chain of amino acids

PREVIEW

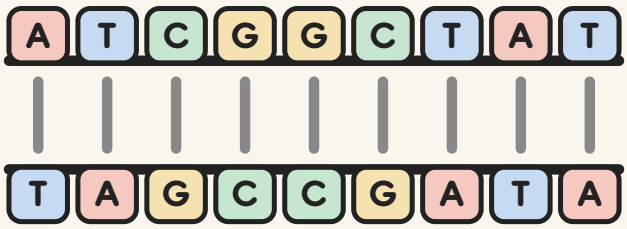
Preview · Bright Path Sped

My name _____ Date _____

Process Cards 1

Read the cards. Use them all week.

DNA



What it is	A long molecule that stores the instructions for proteins
Bases	A, T, C and G
Strands	Two strands twisted together
Where	Stays in the nucleus
Pairs	A with T, and C with G

mRNA



What it is	A copy of one gene
Bases	A, U, C and G (U in place of T)
Strands	One strand
Where	Made in the nucleus, then goes to a ribosome
Made by	Transcription

Pick one card. Tell what it does in your own words.

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

The Codon Chart

Use the chart. Find each amino acid.

Find the first base on the left. Find the second base across the top. Then find the codon. Write the 3-letter name. Write Stop for a stop codon.

	U		C		A		G	
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys
	UUA	Leu	UCA	Ser	UAA	Stop	UGA	Stop
	UUG	Leu	UCG	Ser	UAG	Stop	UGG	Trp
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg
	AUG	Met	ACG	Thr	AAG	Lys	AGG	Arg
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly

First base on the left, second base across the top. Green is the start codon. Red is a stop codon.

1. **AUG** _____
2. **GCU** _____
3. **UUU** _____
4. **GGG** _____
5. **UGG** _____
6. **CCA** _____
7. **UAA** _____
8. **GAC** _____

Which codon is the start codon? Which three are stop codons?

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

DNA and RNA Chart

Fill in the chart with words from the bank.

Pick a word or phrase from the bank for each empty box. Each one is used one time.

one strand **A, T, C, G** **ribose** **stays in the nucleus**
carries a copy of the instructions **deoxyribose** **A, U, C, G** **two strands**
leaves the nucleus **stores the instructions**

Feature	DNA	mRNA
Sugar		
Strands		
Bases		
Where it works		
Job		

Pick one row. Tell why the difference matters.

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

Transcribe: DNA to mRNA

Write the mRNA bases for each DNA strand.

Each DNA strand is a template. Write the partner of each base to make the mRNA.

DNA, then mRNA: A → U, T → A, C → G, G → C

1	DNA	T	A	C	G	G	A	T	C
	mRNA								
2	DNA	A	T	G	C	C	T	A	G
	mRNA								
3	DNA	G	G	A	T	C	A	C	T
	mRNA								
4	DNA	C	A	T	T	G	C	A	G
	mRNA								
5	DNA	A	G	C	T	T	A	C	G
	mRNA								
6	DNA	C	C	G	A	T	G	G	A
	mRNA								

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

tRNA Anticodons

Write the anticodon. Then write the amino acid.

The anticodon pairs with the codon: A with U, and C with G. Write the anticodon. Then use the chart for the amino acid.

	U	C	A	G
U	UUU Phe UUC Phe UUA Leu UUG Leu	UCU Ser UCC Ser UCA Ser UCG Ser	UAU Tyr UAC Tyr UAA Stop UAG Stop	UGU Cys UGC Cys UGA Stop UGG Trp
C	CUU Leu CUC Leu CUA Leu CUG Leu	CCU Pro CCC Pro CCA Pro CCG Pro	CAU His CAC His CAA Gln CAG Gln	CGU Arg CGC Arg CGA Arg CGG Arg
A	AUU Ile AUC Ile AUA Ile AUG Met	ACU Thr ACC Thr ACA Thr ACG Thr	AAU Asn AAC Asn AAA Lys AAG Lys	AGU Ser AGC Ser AGA Arg AGG Arg
G	GUU Val GUC Val GUA Val GUG Val	GCU Ala GCC Ala GCA Ala GCG Ala	GAU Asp GAC Asp GAA Glu GAG Glu	GGU Gly GGC Gly GGA Gly GGG Gly

First base on the left, second base across the top. Green is the start codon. Red is a stop codon.

	mRNA codon		tRNA anticodon		amino acid
1	AUG	→			
2	CCU	→			
3	GAA	→			
4	UUC	→			
5	AAG	→			
6	UGG	→			

PREVIEW

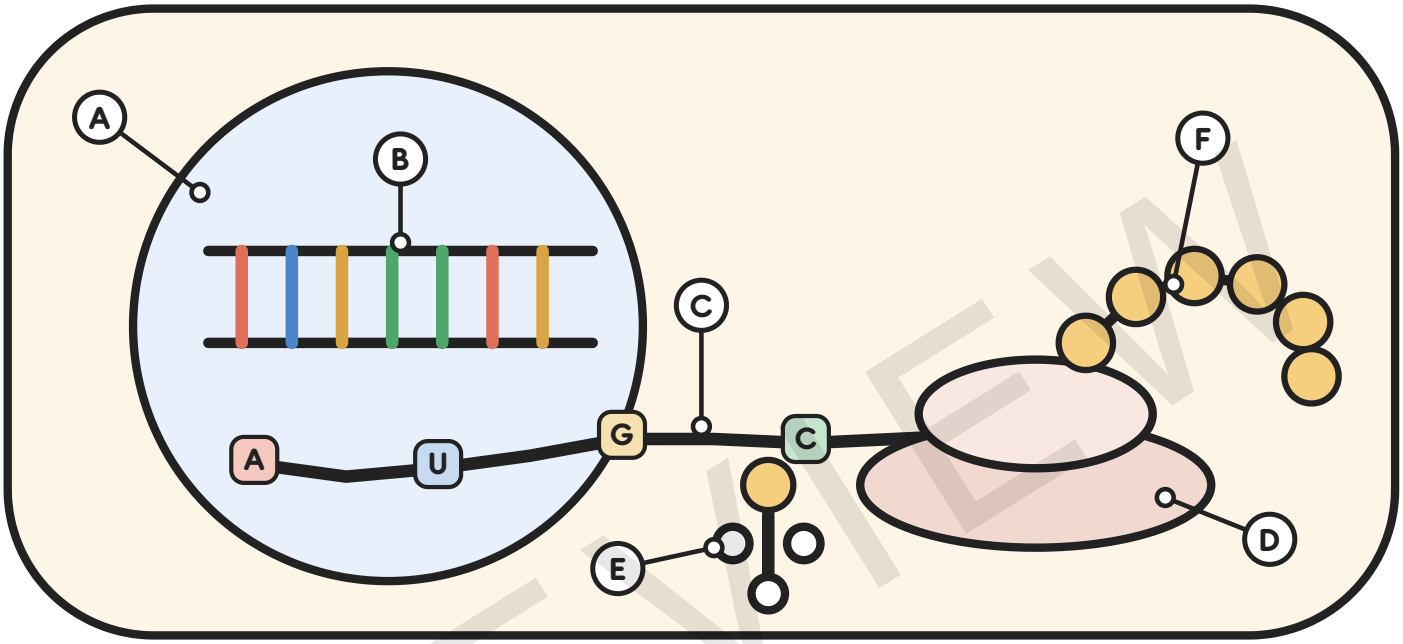
My name _____ Date _____

Label the Cell

Write the name of each lettered part.

A cell makes a protein. Use the words in the bank.

ribosome **DNA** **amino acid chain** **nucleus** **tRNA** **mRNA**



A _____

B _____

C _____

D _____

E _____

F _____

Which part reads the mRNA? Tell what it builds and how you know.

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

True or False 2

Is it true or false? Check one.

Check true or false for each sentence.

7. A tRNA molecule brings an amino acid to the ribosome. ☐ true ☐ false

8. The start codon is UAA. ☐ true ☐ false

9. A protein is a chain of amino acids. ☐ true ☐ false

10. An anticodon is found on mRNA. ☐ true ☐ false

11. The ribosome reads mRNA one base at a time. ☐ true ☐ false

12. UGA is a stop codon. ☐ true ☐ false

Pick one false sentence. Fix it so it is true.

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

Short Answers 2

Answer each question in sentences.

Use facts from the readings and the cards. Write in sentences.

4 How are DNA and mRNA different? Name two ways.

5 What do the start codon and the stop codons do?

6 How does a tRNA match the right amino acid to a codon?

PREVIEW

My name _____ Date _____

Quiz B

Pick the best answer. Write its letter.

Take your time. Guess if you are not sure.

7 What happens to mRNA after transcription?

- **A** It leaves the nucleus
- **B** It stays in the nucleus forever
- **C** It turns back into DNA

8 The mRNA codon is CCU. What is the tRNA anticodon?

- **A** CCU
- **B** GGA
- **C** GGU

9 Which codon codes for the amino acid Trp?

- **A** UGA
- **B** UUG
- **C** UGG

10 What is made at the end of translation?

- **A** A chain of amino acids that folds into a protein
- **B** A new strand of DNA
- **C** A copy of the gene as mRNA

11 How many bases are in one codon?

- **A** 2
- **B** 3
- **C** 4

12 The mRNA reads AUG GCU UAA. How many amino acids are added before the stop codon?

- **A** 2
- **B** 3
- **C** 1

PREVIEW

My name _____ Date _____

Check My Own Work

Check your own work. Mark yes or not yet.

1	I can say what DNA does.	☐ yes	☐ not yet
2	I can say what mRNA is and where it goes.	☐ yes	☐ not yet
3	I can make an mRNA from a DNA strand.	☐ yes	☐ not yet
4	I can use the codon chart to find an amino acid.	☐ yes	☐ not yet
5	I can say what a tRNA anticodon does.	☐ yes	☐ not yet
6	I can find the start codon and the stop codons.	☐ yes	☐ not yet
7	I can tell transcription from translation.	☐ yes	☐ not yet
8	I can put the steps of protein synthesis in order.	☐ yes	☐ not yet

The step I can explain best is...

The part I still need help with is...

PREVIEW

Preview · Bright Path Sped

My name _____ Date _____

Cut and Paste 2: Transcription or Translation

Cut out the twelve pieces. Paste each one in the right box.

Transcription	Translation

PREVIEW

Cut on the dashed lines: twelve pieces, two cuts across and three cuts down.

A in DNA pairs with U in mRNA	tRNA brings amino acids	Happens at a ribosome	Happens in the nucleus
DNA is the template	Starts at the start codon AUG	Builds a chain of amino acids	Makes a strand of mRNA
Copies one gene	Reads mRNA one codon at a time	Ends at a stop codon	RNA bases pair with DNA bases

Answer Key: Compare, Worked Example, Labels

In the DNA and RNA sentences, RNA means mRNA.

DNA and RNA Chart page 11

Feature	DNA	mRNA
Sugar	deoxyribose	ribose
Strands	two strands	one strand
Bases	A, T, C, G	A, U, C, G
Where it works	stays in the nucleus	leaves the nucleus
Job	stores the instructions	carries a copy of the instructions

Worked Example: your turn page 13

Step	Answer
Step 1 and 2: mRNA for TTC GAC	AAG CUG
Check	No. There is no T in mRNA.

DNA, RNA or Both? page 12

Sentence	Answer
1. Has the base thymine (T).	DNA
2. Has the base uracil (U).	RNA
3. Has the bases A, C and G.	both
4. Is a double strand.	DNA
5. Is made during transcription.	RNA
6. Stores the instructions for proteins.	DNA
7. Is a single strand.	RNA
8. Is made of a string of bases.	both

Label the Cell page 18

Letter	Name	How to tell
A	nucleus	the large round part that holds the DNA
B	DNA	the ladder-shaped strand inside the nucleus
C	mRNA	the single strand leaving the nucleus
D	ribosome	the two-part shape the mRNA passes through
E	tRNA	the small piece that carries one amino acid
F	amino acid chain	the string of circles growing from the ribosome

PREVIEW

Answer Key: Writing

These pages have no single right sentence. Accept any answer that uses a fact from the readings or the cards.

Short answers: what to look for pages 21, 22

Item	Look for
21.1	A gene in the DNA is copied into mRNA. It happens in the nucleus.
21.2	A ribosome reads the mRNA codons, and tRNA brings amino acids that join into a chain. It happens at a ribosome.
21.3	The DNA stays in the nucleus. The mRNA copy can leave the nucleus and carry the instructions to a ribosome.
22.1	mRNA has one strand and DNA has two; mRNA has U where DNA has T; mRNA has ribose and DNA has deoxyribose.
22.2	AUG starts translation (and codes for Met). UAA, UAG and UGA end it.
22.3	Its anticodon pairs with the codon base by base, and it carries the amino acid that codon stands for.

PREVIEW

Exit tickets

- Exit tickets (page 26): ticket 1 names transcription (in the nucleus) and translation (at a ribosome); ticket 2 is the mRNA AUG CCU for the DNA strand TAC GGA; ticket 3 is open.

What a strong written answer includes

- It names the step (transcription or translation) and where it happens (the nucleus, or a ribosome).
- It uses at least one word from the cards: DNA, mRNA, tRNA, codon, anticodon, amino acid.
- It says what the step makes: an mRNA copy, or a chain of amino acids.

Protein Synthesis Tracker

One student, every scored sheet. Filled example: page 40.

Student _____ Teacher _____ Month _____

Page	Page type and set	Items	Right	Date	Notes
5	Reading 1: Cells Make Proteins	3			
6	Reading 2: Transcription and Translation	3			
9	The Codon Chart	8			
10	Protein Words	6			
11	DNA and RNA Chart	10			
12	DNA, RNA or Both?	8			
14	Transcribe: DNA to mRNA	6			
15	Translate: mRNA to Amino Acids	4			
16	tRNA Anticodons	6			
17	From DNA to Protein	3			
18	Label the Cell	6			
19	True or False 1	6			
20	True or False 2	6			
23	Find the Mistake	4			
24	Quiz A	6			
25	Quiz B	6			
28	Cut and Paste 1: Put the Steps in Order	12			
29	Cut and Paste 2: Transcription or Translation	12			

PREVIEW

How to fill this in

Write how many items the student got right with no prompt, and the date. A blank means not tried yet, never wrong. There are 115 items on the 18 scored sheets. Answer keys: pages 30 to 35. Filled example: page 40.

This month we are working on (your own standard or wording)

Team Note

Use this page between team meetings or when a student moves classes, to hand off what changed without writing a note from scratch. Everything below is observable, with a blank for the number or the wording your team already uses.

Student _____ Team member _____ Date _____

Kind of sheet	Covered since last note (Y/N)	Items right	Still blank
Readings and words			
DNA and RNA			
Strands			
Label the cell			
True or false			
Quizzes			
Cut and paste			

What I saw (observable, not a conclusion)

- Made the mRNA for ___ of 6 DNA strands (page 14).
- Named ___ of 6 parts on the cell (page 18).
- Got ___ of 12 true or false sentences right (pages 19, 20).
- Explained in a complete sentence what happens in transcription and in translation: yes / no / with a reminder.

Next step

- Next page or set: ___, because ___ (what you saw).
- What to try in another class or at home: ___.
- What to keep doing because it is working: ___.
- Anything for the team meeting to decide: ___ (this page records what happened, never a label or a plan).

Summary, in one or two sentences, for whoever reads this next

A filled-in line, for reference

"Got 3 of 6 true or false sentences right on 10/20. Next step: reread Reading 2 and ask where transcription happens and where translation happens." That is the level of detail this page is built for. It matches the filled example on page 40.

PREVIEW

Priya's Tracker (Invented Student)

Priya R. is invented; nothing on this page describes a real student. The blank tracker is on page 36.

Student	Teacher	Month
Priya R. (an invented student)	Ms. Rivera (invented)	October

Page	Page type and set	Items	Right	Date	Notes
5	Reading 1: Cells Make Proteins	3	3	10/6	-
6	Reading 2: Transcription and Translation	3	2	10/7	Mixed up transcription and translation
9	The Codon Chart	8	-	-	-
10	Protein Words	6	5	10/8	Swapped codon and anticodon
11	DNA and RNA Chart	10	8	10/13	Wrote T for the mRNA bases
12	DNA, RNA or Both?	8	-	-	-
14	Transcribe: DNA to mRNA	6	6	10/15	-
15	Translate: mRNA to Amino Acids	4	-	-	-
16	tRNA Anticodons	6	-	-	-
17	From DNA to Protein	3	-	-	-
18	Label the Cell	6	4	10/16	Mixed up tRNA and mRNA
19	True or False 1	6	3	10/20	Thought translation is in the nucleus
20	True or False 2	6	-	-	-
23	Find the Mistake	4	-	-	-
24	Quiz A	6	5	10/22	Missed which codon is a stop codon
25	Quiz B	6	-	-	-
28	Cut and Paste 1: Put the Steps in Order	12	-	-	-
29	Cut and Paste 2: Transcription or Translation	12	10	10/24	Put the start codon piece under transcription

How to read it

Priya R. has done **9 of 18** scored sheets and got **46 of 58** items right with no prompt. **2** sheets were all right and **7** carry a note. Every number comes from the table.

What the table points to

The lowest sheet is True or False 1 (3 of 6). That is where the next practice goes. The 9 sheets left blank are not tried yet, never wrong.

PREVIEW