AS/A2

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Friday Afternoon Biology

RESOURCE PACK

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Biology

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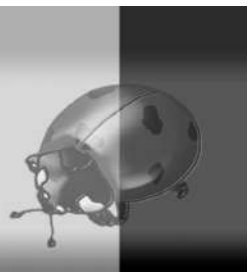
Introduction



Why use these activities?

First and foremost, these activities are fun. They help engage students, creating situations in which they can enjoy lessons, and although students might regard many of these activities as games, their potential for knowledge building is powerful. Such an approach makes learning active rather than passive, a methodology that has been advocated by many current educational gurus, such as Geoff Petty and Robert Powell.

Many educational theorists favour formative learning: students need to be tested regularly in order to build confidence, highlight areas of weakness, and allow for reflection and discussion of topics studied in class. These activities give direct feedback to students on their level of understanding of key terms and concepts.

Students work best using a variety of learning styles. The work of theorists such as Howard Gardner advises that revision activities should be varied, allowing students to work in small groups (matching, triominoes) and whole-class groups (dominoes, bingo), as well as individually. This taps into linguistic, logical, interpersonal and intrapersonal intelligence traits. The use of small cards also fulfils the requirements of kinaesthetic learners. Students possess all these intelligences, and more, to different degrees. If they only use one learning style, for example answering exam-style questions, this fails to tap into their multiple intelligences.

Ofsted expects students to understand and show confidence in using relevant terminology and concepts. The activities in this pack seek to reinforce and build upon prior learning — this is useful for teachers and gives a confidence boost to students.

How to use this pack

Dominoes

There are several uses for these cards.

Whole-class activity

Photocopy one set of dominoes onto card. Each domino has a question on one half and an answer (to another question) on the other half. Cut out the dominoes and give one or more to each student. One student starts by reading out the question on his or her domino; the other students listen and read out their answer if they think it is the correct one. The student who has read the correct answer then reads the question from the same domino and the game continues until every student has answered. The game will finish with the person who read their question first.

If there are blank faces after a particular question, you can clarify it or give the correct answer so that the game will continue with each domino card being followed by the

next one in the correct sequence. You can check answers by looking at the teacher answer sheet, which shows the correct sequence.

Small-group dominoes

Photocopy several sets of dominoes and cut them out as before. Students should be divided into groups of three or four and each group given a complete set of dominoes (you may wish to copy each set onto different coloured card to prevent the sets becoming mixed up). Dominoes are dealt equally, and the youngest player places the first one. Play then moves to the left, and each player should lay a domino with a corresponding answer (or question) to a domino already on the table. The winner is the player who gets rid of his or her dominoes first. Students should 'knock' (tap the table and miss a turn) if they cannot place a domino.

An alternative method is to give each group a complete set of dominoes and ask students to make a complete chain of connected dominoes, working as a team rather than taking turns. Again, reward the group that finishes first.

Matching

Photocopy several sets of a matching exercise onto card and cut them up. In groups of two or three, students should match each tinted card to its white partner. This generates excellent discussion, as does the matching itself. When students have completed the exercise, circulate a copy of the correct terms and definition.

Triominoes

Photocopy several sets of triominoes onto card and cut them out. In small groups, students should be given the central black triangles and outer triangles separately, and asked to match three outer triangles to each of the relevant central topics (as on the original templates).

Play your cards right

Photocopy the cards and cut them out. Each student needs a set of the cards. Ask students to stand up, holding their cards. Read out the first definition — students must then quickly hold up the most appropriate card for the definition. Students who hold up a wrong answer must sit down. The game continues until only one person is standing — this student has won and could be rewarded with a small prize (come prepared with a chocolate bar).

Bingo

Photocopy the bingo card and give one to each student. Ask students to select terms from the list provided to fill their card. Read out definitions randomly from the list provided, and ask students to listen carefully and cross off each term on their cards once they think it has been defined. When all the terms on their card have been crossed off, students should shout 'bingo!' The first student to shout out should read out the terms on his or her card, so you can check they were defined. This game helps students to learn

vocabulary, concentrate on terminology and have fun at the same time. Come prepared with a prize for the winner if you feel generous.

Variation

Ask the winning student to repeat the definitions as he or she reads out the terms on the winning card. Other students could assist, in order to help learning further.

Jigsaws

Jigsaws comprise a set of cards with statements around the edges. Each statement can be matched to another on a different card. In this way, a larger shape (hexagon or rectangle), is built up as the statements are matched (placed alongside each other). Card edges without statements form the perimeter of the jigsaw. These activities are more demanding and may be useful for 'stretch and challenge'.

Diamonds

Photocopy each grid onto thin card, and cut through the thick black lines. Organise your students into pairs. They should consult with each other to match eight of the cards around each shaded square. Discussion is generated as they attempt to match the cards.

Sequencing

Each set contains cards with a description of the stages of a biological process(es). Where there is more than one sequence in the activity (e.g. nerve impulse and synaptic transmission) the cards must first be sorted into the processes before sequencing. Students should work in pairs or small groups, and each group must decide on the correct sequence(s) by placing the cards in one or more columns.

Timing of activities

It is difficult to provide times here, as it depends on whether you decide to intervene — for example, you might stop a dominoes activity whenever someone has difficulty and explain the key concept in depth to the whole class. Naturally, this will lengthen timings from the rough guidelines given below.

Activity	**Timing**
Bingo	10–15 minutes
Diamonds	5–10 minutes
Dominoes	10–15 minutes
Jigsaws	10–20 minutes
Matching	10 minutes (plus 5–10 minutes to go through the answers)
Play your cards right	10 minutes
Sequencing	10–15 minutes (plus 5 minutes to go through the answers)
Triominoes	10–15 minutes (plus 5 minutes to go through the answers)

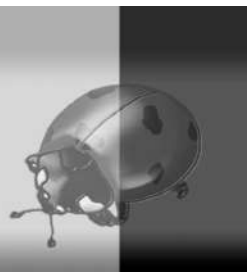
Take the time to pick up on any problems your students have. These activities can highlight areas of knowledge that students are lacking — it is up to you to use the time wisely.

When to use the activities

Most of these activities can be used at the start, middle or end of a lesson. For example, dominoes exercises are useful at the start of a lesson, giving students something to do while latecomers arrive. A more interactive activity, such as play your cards right, can add variation in the middle of a long theoretical session.

The activities are also useful for revisiting a particular module or topic — for example, when teaching genes and DNA technology, you could introduce a game of nucleic acid matching dominoes to add variety and revisit prior learning.

Content and specification coverage



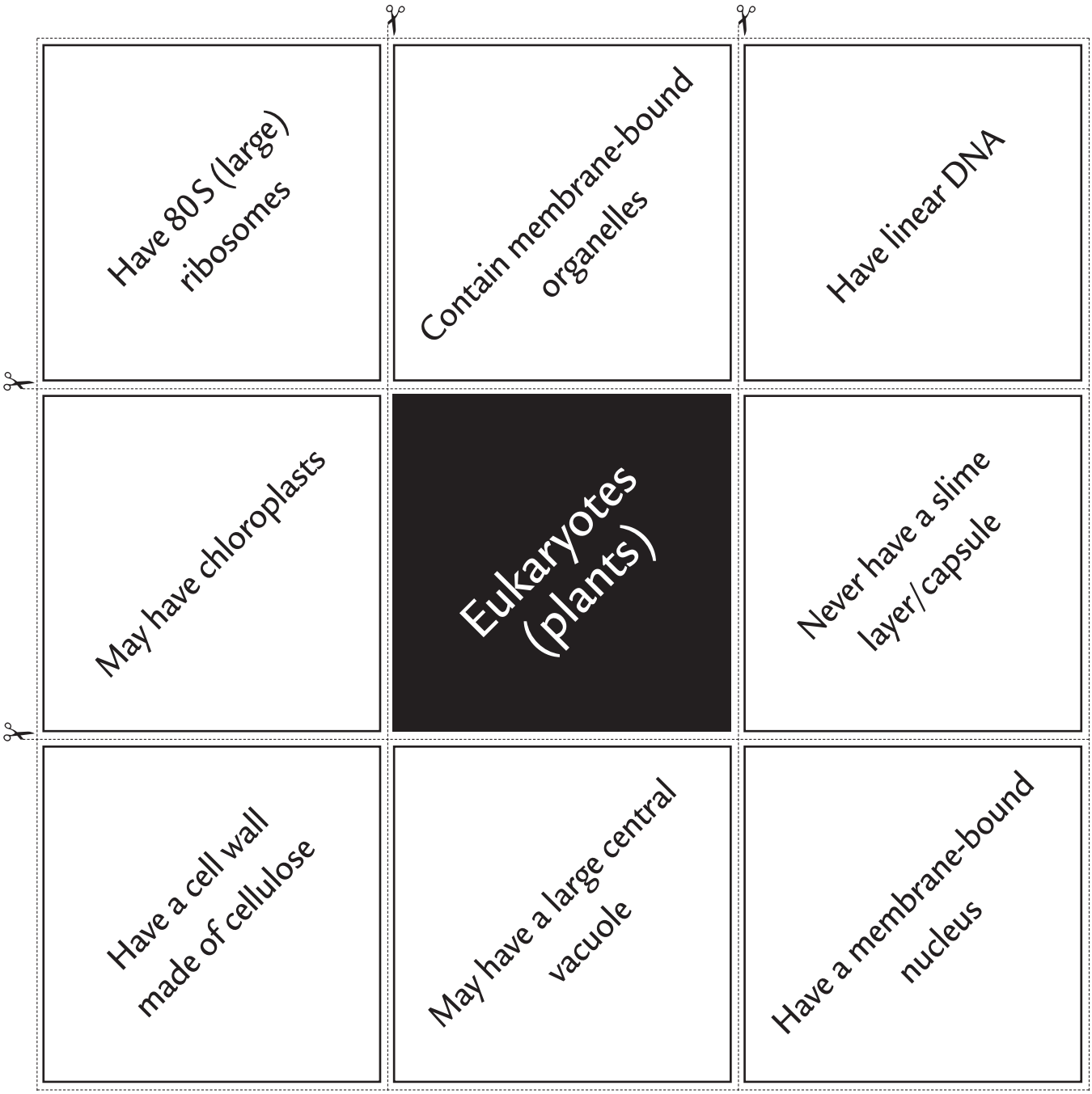
Topic	Pages	AQA		EDEXCEL		OCR	
		AS	A2	AS	A2	AS	A2
1 Cell structure and function							
AS Diamonds: Cells and microscopy	10–14	✓		✓		✓	
AS Dominoes: Cell structure	15–19	✓		✓		✓	
AS Play your cards right: Cell organelles	20–23	✓		✓		✓	
AS Triominoes: Cell organelles	24–27	✓		✓		✓	
2 Cell division							
AS Diamonds: Cell division	29–31	✓		✓		✓	
AS Dominoes: Mitosis	32–36	✓		✓		✓	
AS Matching: Mitosis	37–42	✓		✓		✓	
AS Triominoes: Meiosis	43–48	✓		✓		✓	
3 Biological molecules							
AS Bingo: Enzymes	50–51	✓		✓		✓	
AS Dominoes: Enzymes	52–56	✓		✓		✓	
AS Matching: Nucleic acids	57–63	✓		✓		✓	
AS Play your cards right: Biological molecules	64–66	✓		✓		✓	
4 Transport and exchange							
AS Bingo: Heart and circulation	68–69	✓		✓		✓	
AS Diamonds: Cardiac cycle	70–72	✓		✓		✓	
AS Dominoes: Heart and circulation	73–77	✓		✓		✓	
AS Dominoes: Membranes	78–82	✓		✓		✓	
AS Jigsaw: Transport across membranes	83–86	✓		✓		✓	
AS Matching: Heart and heart disease	87–93	✓		✓		✓	
5 Genes and DNA technology							
A2 Bingo: DNA technology	95–96		✓		✓		✓
AS/A2 Matching: Genetics	97–105		✓	✓		✓	
A2 Sequencing: DNA fingerprinting/electrophoresis	106–107		✓		✓		✓
A2 Sequencing: Protein synthesis	108–110		✓		✓		✓
A2 Sequencing: Recombinant DNA technology	111–112		✓		✓		✓

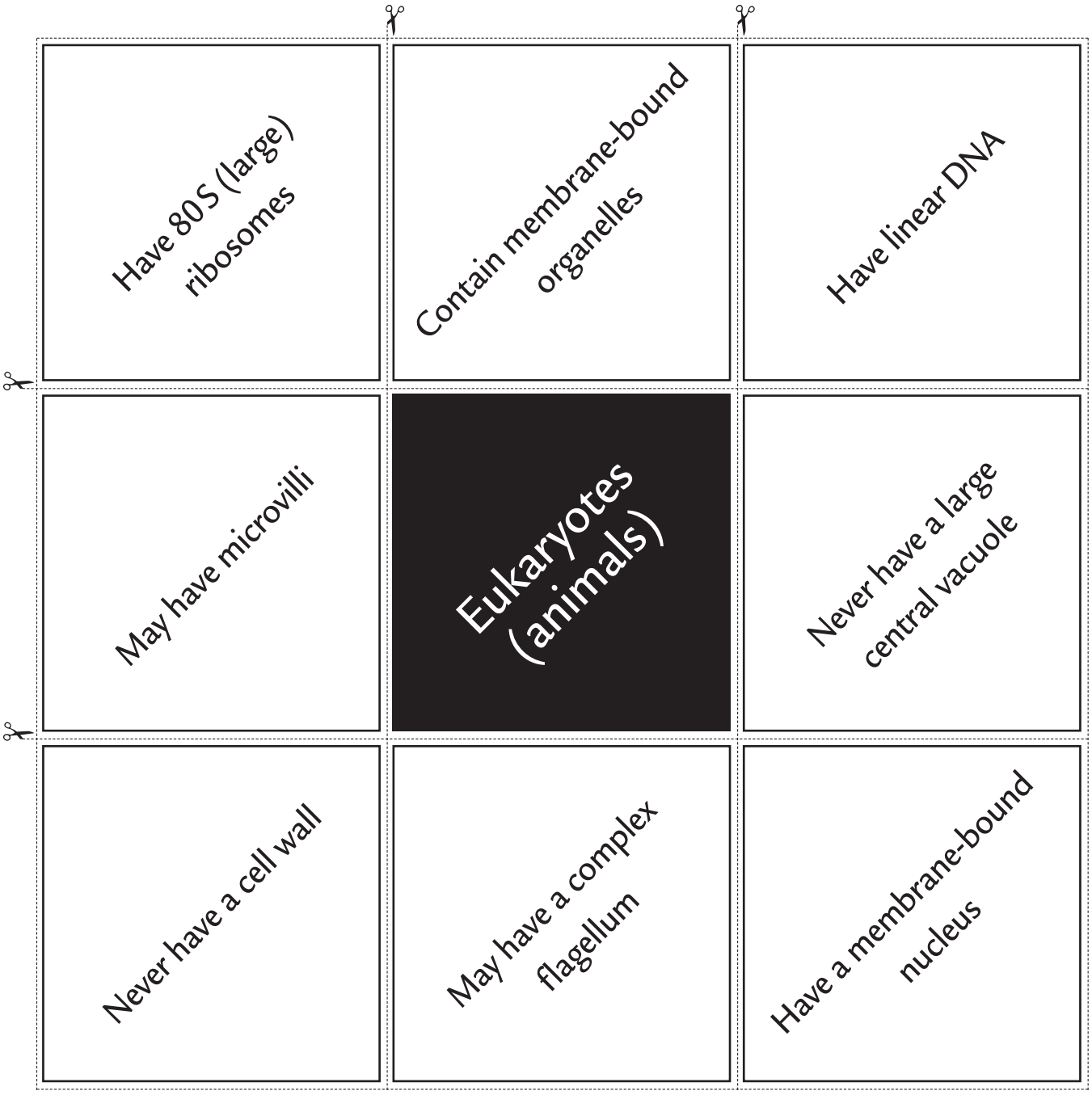
1 Cell structure and function

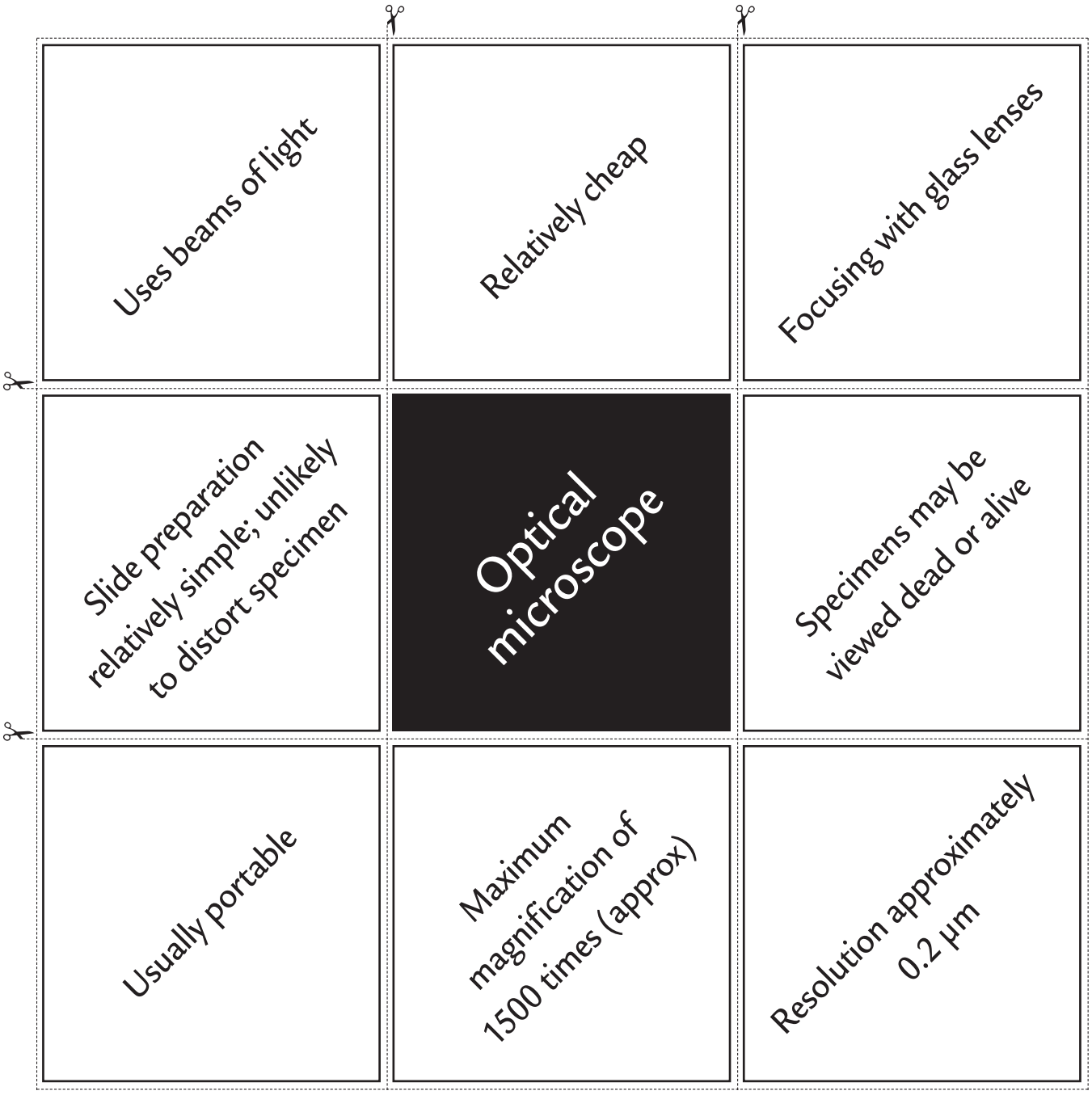
- AS Diamonds: Cells and microscopy
- AS Dominoes: Cell structure
- AS Play your cards right: Cell organelles
- AS Triominoes: Cell organelles

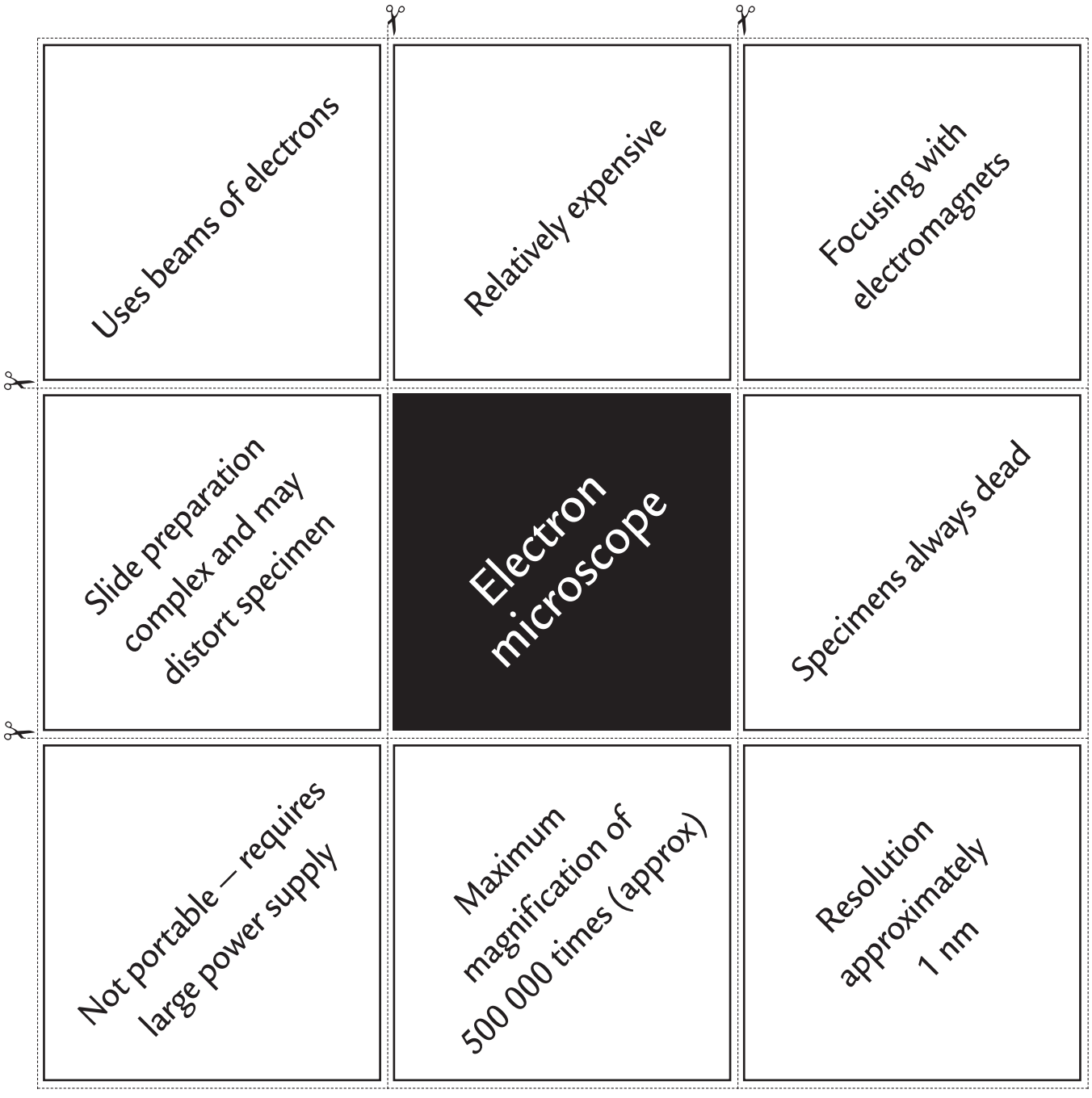
AS Diamonds: Cells and microscopy

Have 70S (small) ribosomes	Do not contain membrane-bound organelles	Have circular DNA
Have mesosomes	**Prokaryotes**	May have a slime layer/capsule
Have a cell wall made of peptidoglycan	May have a simple flagellum	Do not have a nucleus









AS Dominoes: Cell structure

Q What is the main function of the nucleolus?

A Lysosome

Q What substance is the plant cell wall made of?

A Exocytosis

Q Which organelle is the site of respiration in a prokaryotic cell?

A Golgi apparatus

Q How many membranes surround the nucleus?

A 80 S

Q Which structures increase the surface area of the inner mitochondrial membrane?

A Control of transport into and out of the cell

Q What is the function of the plasma membrane?

A Chloroplast

AS Dominoes: Cell structure

A	Q
Ribosome	What is the main function of the mitochondrion?
Mesosome	Prokaryotes contain which type of ribosomes?
Production of ribosomal RNA	Which organelle is made of stacks of membranes and covered in ribosomes?
Rough ER	Which organelle packages proteins for export from the cell by exocytosis?
Smooth ER	Which organelle contains hydrolytic enzymes?
Eukaryotic	Which organelle contains chromatin?

AS Dominoes: Cell structure

A	Q
Peptidoglycan	Which term means 'before the nucleus'?
Mitochondrion	Which organelle is never found in prokaryotes or animals cells?
70 S	What substance forms the cell wall of prokaryotes?
Chlorophyll	Which term means 'true nucleus'?
Microvilli	Which pigment makes chloroplasts green?
Two	Which organelle in animal cells, other than the nucleus, also contains DNA?

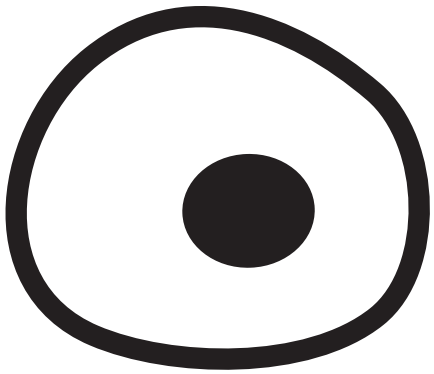
AS Dominoes: Cell structure

A	Q
Cristae	Which process describes how proteins are exported from cells?
Centriole	Which organelle is responsible for the synthesis of lipids in the cell?
Nucleus	Which organelle is the site of translation?
Prokaryotic	Which type of ribosomes do eukaryotes contain in their cytoplasm?
Aerobic respiration	Which organelle produces the spindle fibres during mitosis?
Cellulose	Which structures present in some animal cells increase the surface area of the cell membrane?

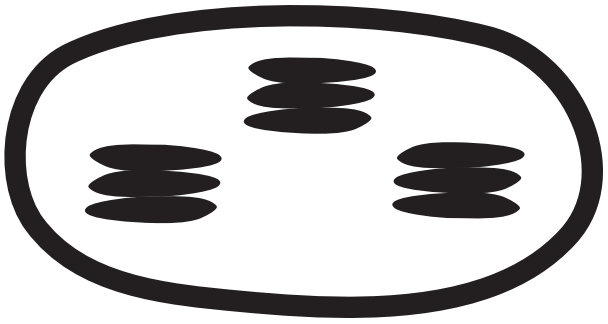
Teacher answers

A	Q
Eukaryotic	Which organelle contains chromatin?
Nucleus	Which organelle is the site of translation?
Ribosome	What is the main function of the mitochondrion?
Aerobic respiration	Which organelle produces the spindle fibres during mitosis?
Centriole	Which organelle is responsible for the synthesis of lipids in the cell?
Smooth ER	Which organelle contains hydrolytic enzymes?
Lysosome	What is the main function of the nucleolus?
Production of ribosomal RNA	Which organelle is made of stacks of membranes and covered in ribosomes?
Rough ER	Which organelle packages proteins for export from the cell by exocytosis?
Golgi apparatus	Which organelle is the site of respiration in a prokaryotic cell?
Mesosome	Prokaryotes contain which type of ribosomes?
70S	What substance forms the cell wall of prokaryotes?
Peptidoglycan	Which term means 'before the nucleus'?
Prokaryotic	Which type of ribosomes do eukaryotes contain in their cytoplasm?
80S	How many membranes surround the nucleus?
Two	Which organelle in animal cells, other than the nucleus, also contains DNA?
Mitochondrion	Which organelle is never found in prokaryotes or animals cells?
Chloroplast	What is the function of the plasma membrane?
Control of transport into and out of the cell	Which structures increase the surface area of the inner mitochondrial membrane?
Cristae	Which process describes how proteins are exported from cells?
Exocytosis	What substance is the plant cell wall made of?
Cellulose	Which structures present in some animal cells increase the surface area of the cell membrane?
Microvilli	Which pigment makes chloroplasts green?
Chlorophyll	Which term means 'true nucleus'?

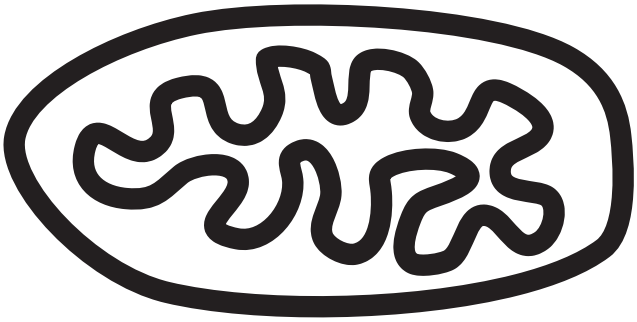
AS: Play your cards right: Cell organelles



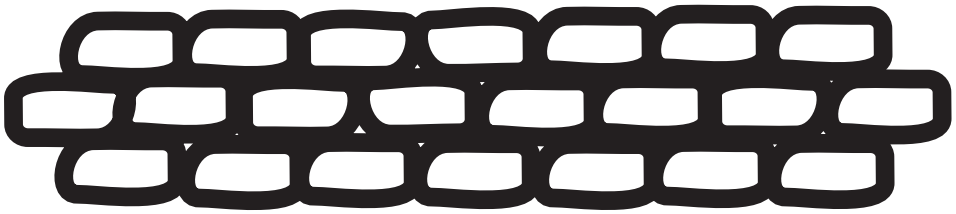
Nucleus



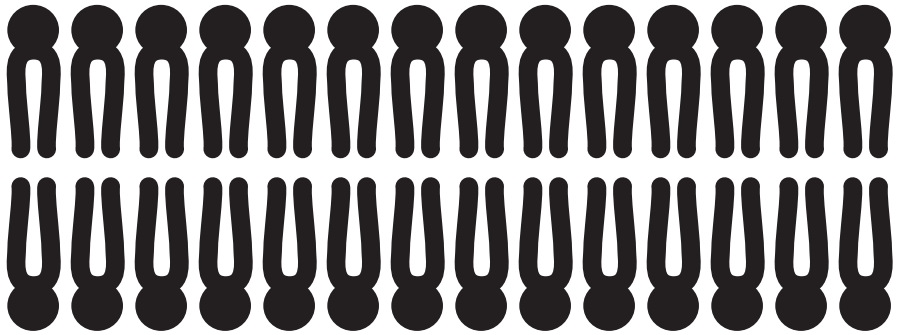
Chloroplast



Mitochondrion



Cell wall

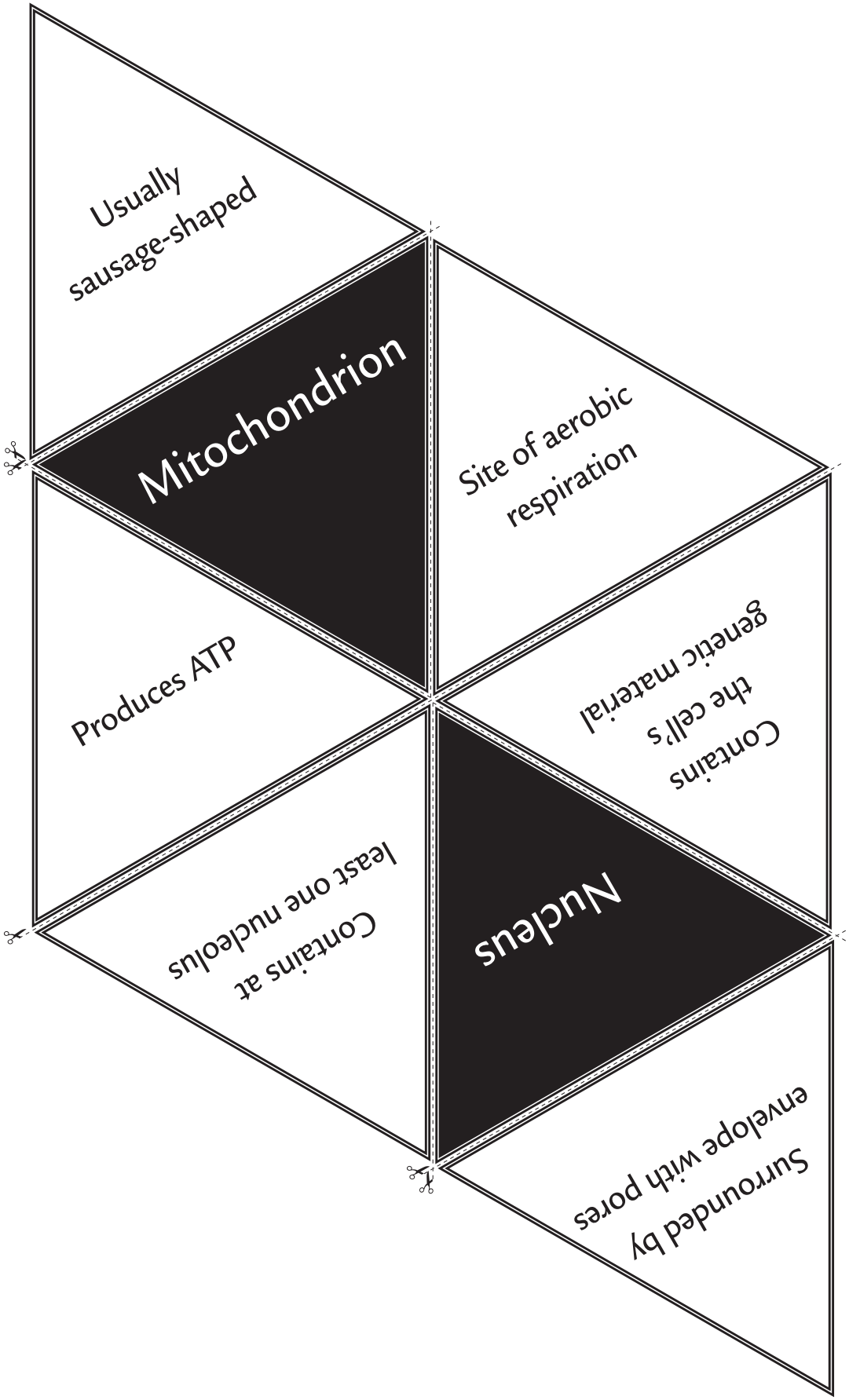


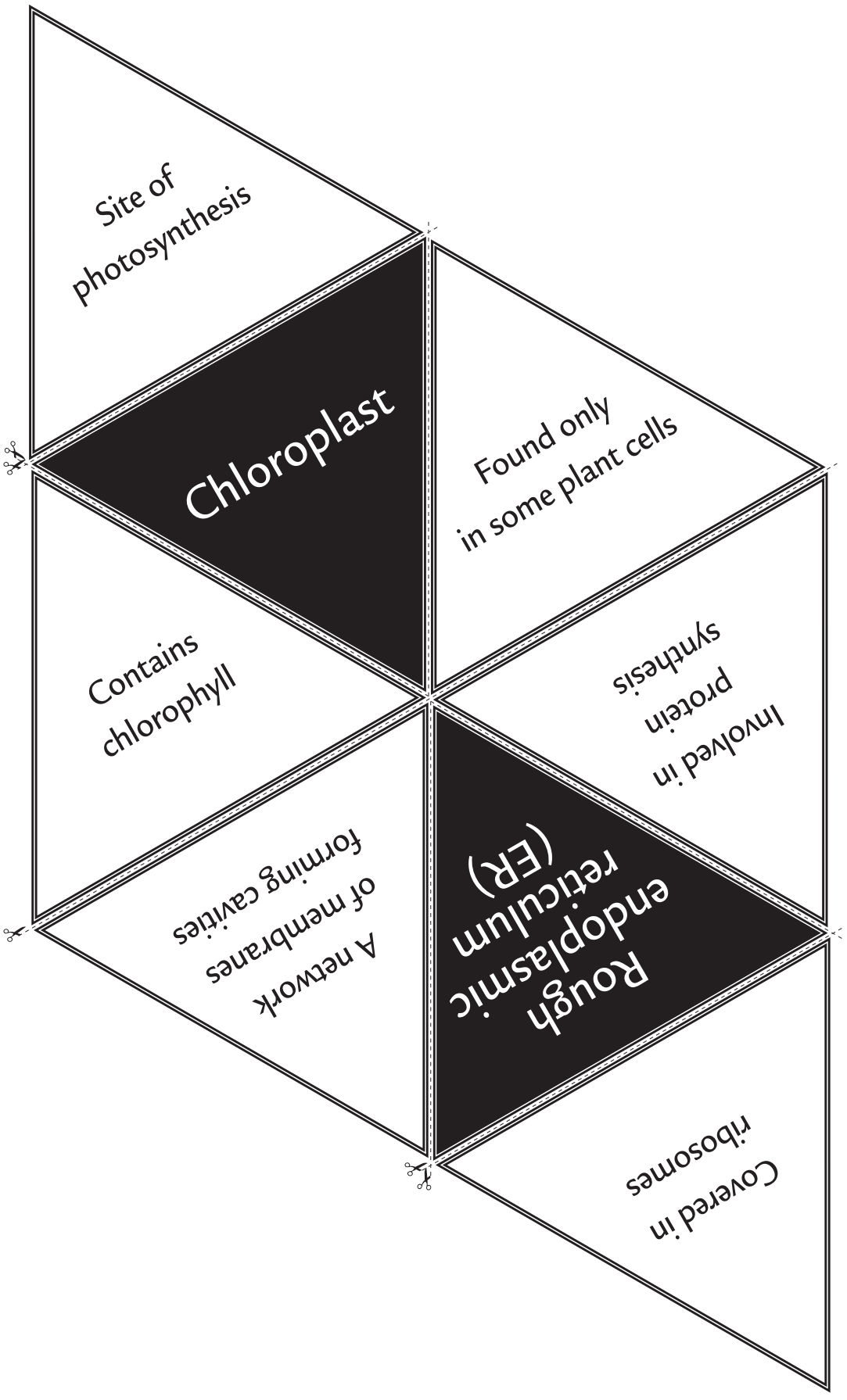
Cell membrane

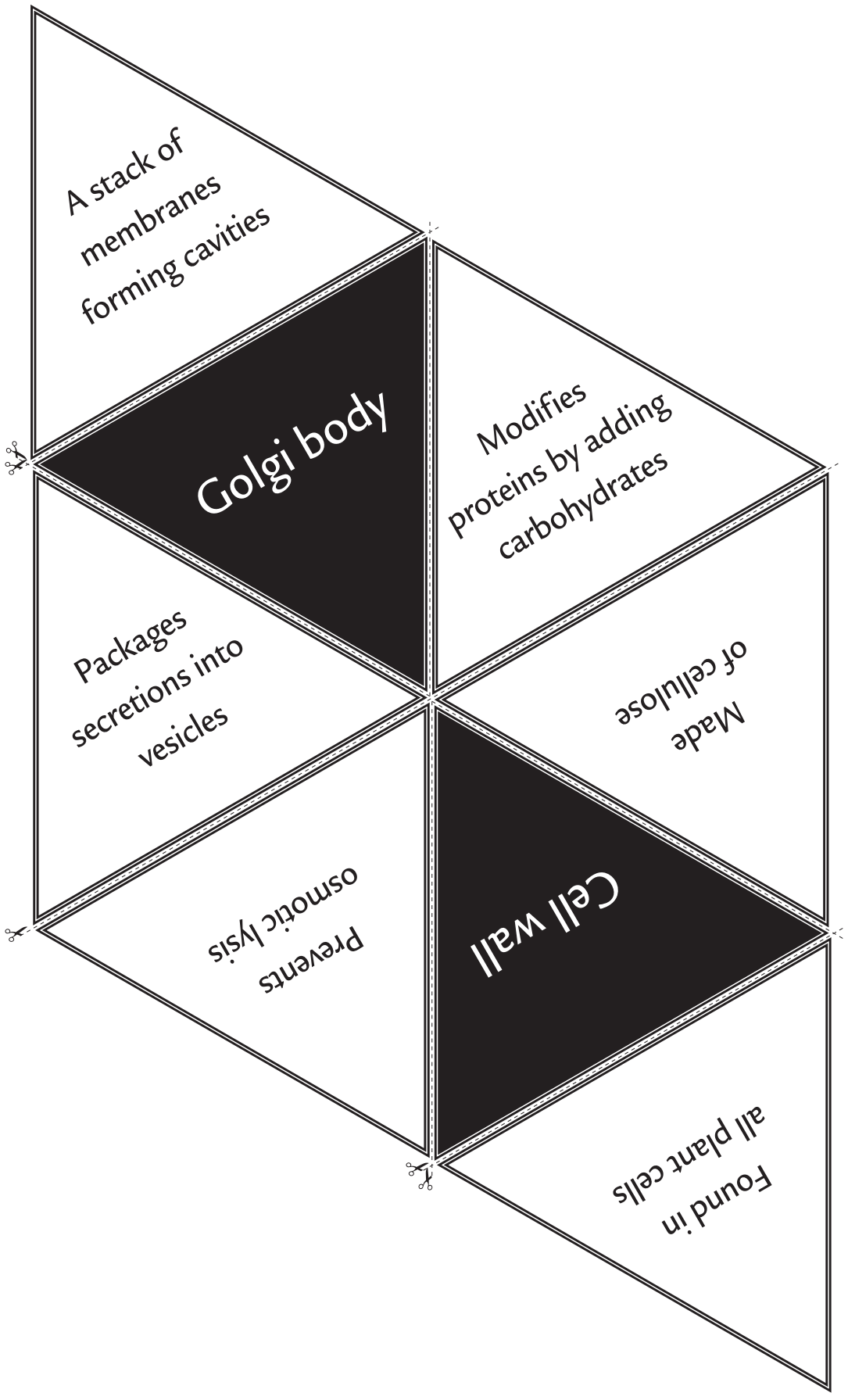
Teacher questions and answers

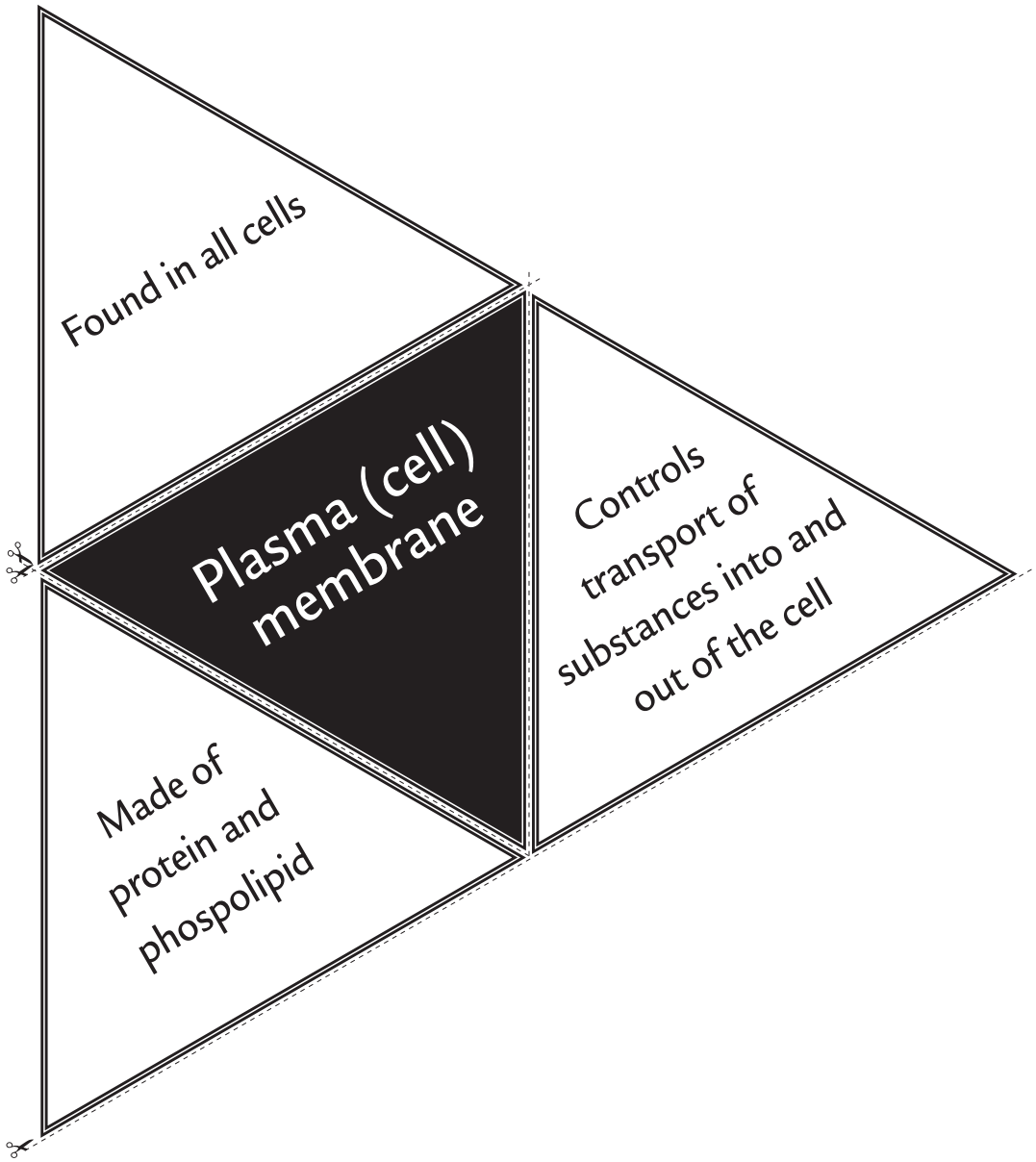
This organelle contains chlorophyll	Chloroplast
This organelle carries out aerobic respiration	Mitochondrion
This organelle contains the genetic material of the cell	Nucleus
This organelle is made of cellulose	Cell wall
This plant organelle is found on the outside of the cell	Cell wall
This organelle carries out photosynthesis	Chloroplast
This organelle has an envelope with pores in it	Nucleus
This organelle contains folds called cristae	Mitochondrion
This organelle produces oxygen	Chloroplast
This organelle controls transport of materials into and out of the cell	Cell membrane
This organelle is not made of membrane	Cell wall
This organelle contains starch	Chloroplast
This organelle may contain chromosomes	Nucleus
This organelle requires oxygen to work	Mitochondrion
This organelle has a structure described by the fluid mosaic model	Cell membrane
This organelle contains one or more nucleoli	Nucleus
This organelle is usually sausage-shaped	Mitochondrion
This organelle contains thylakoids	Chloroplast
This organelle is only 7 nm (7 billionths of a metre) thick	Cell membrane
This organelle prevents osmotic lysis (in plant cells and bacteria)	Cell wall
This organelle contains stroma	Chloroplast
This organelle contains matrix	Mitochondrion
This organelle is freely permeable	Cell wall

AS Triominoes: Cell organelles









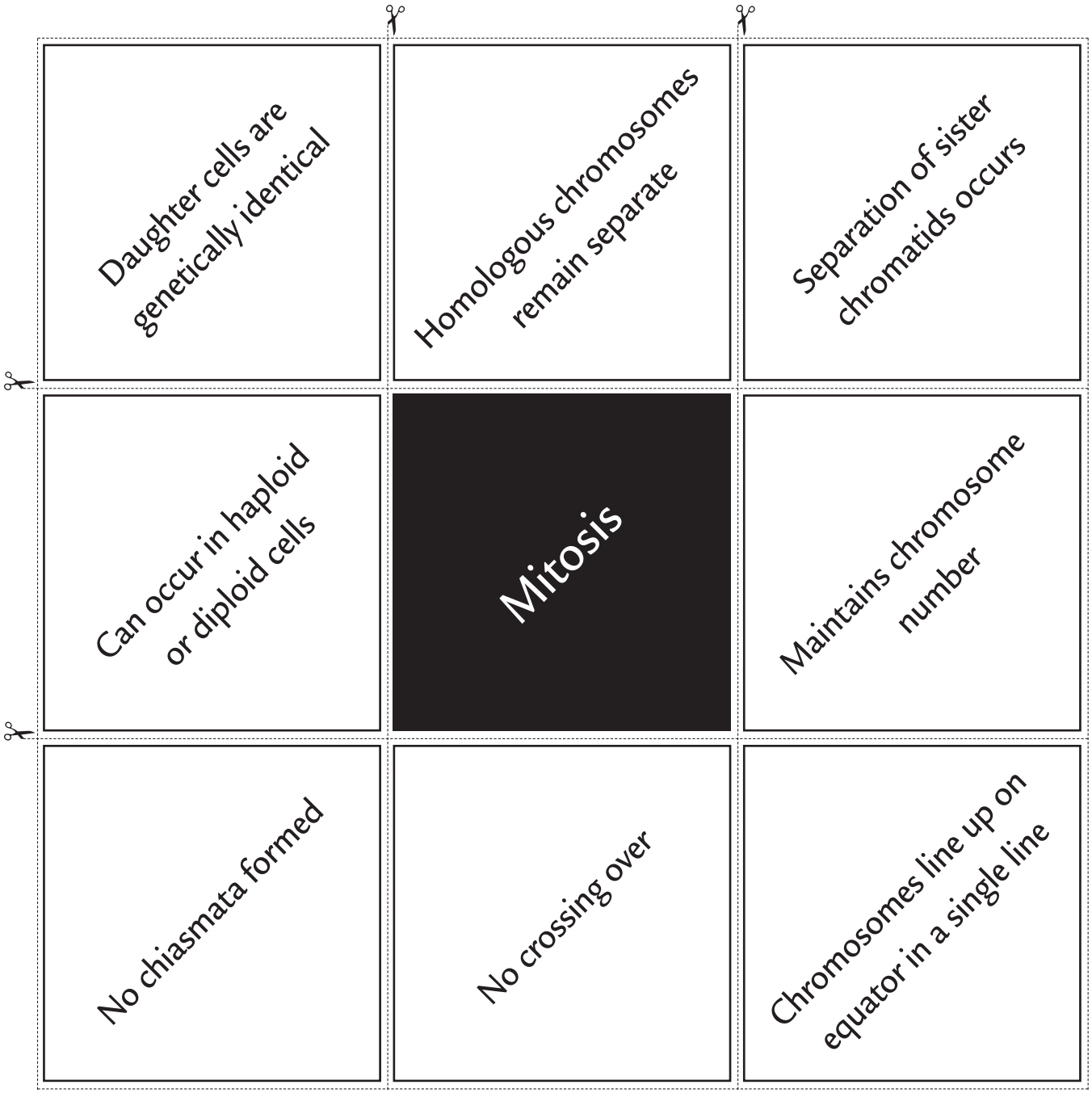
2 Cell division

- AS Diamonds: Cell division
- AS Dominoes: Mitosis
- AS Matching: Mitosis
- AS Triominoes: Meiosis

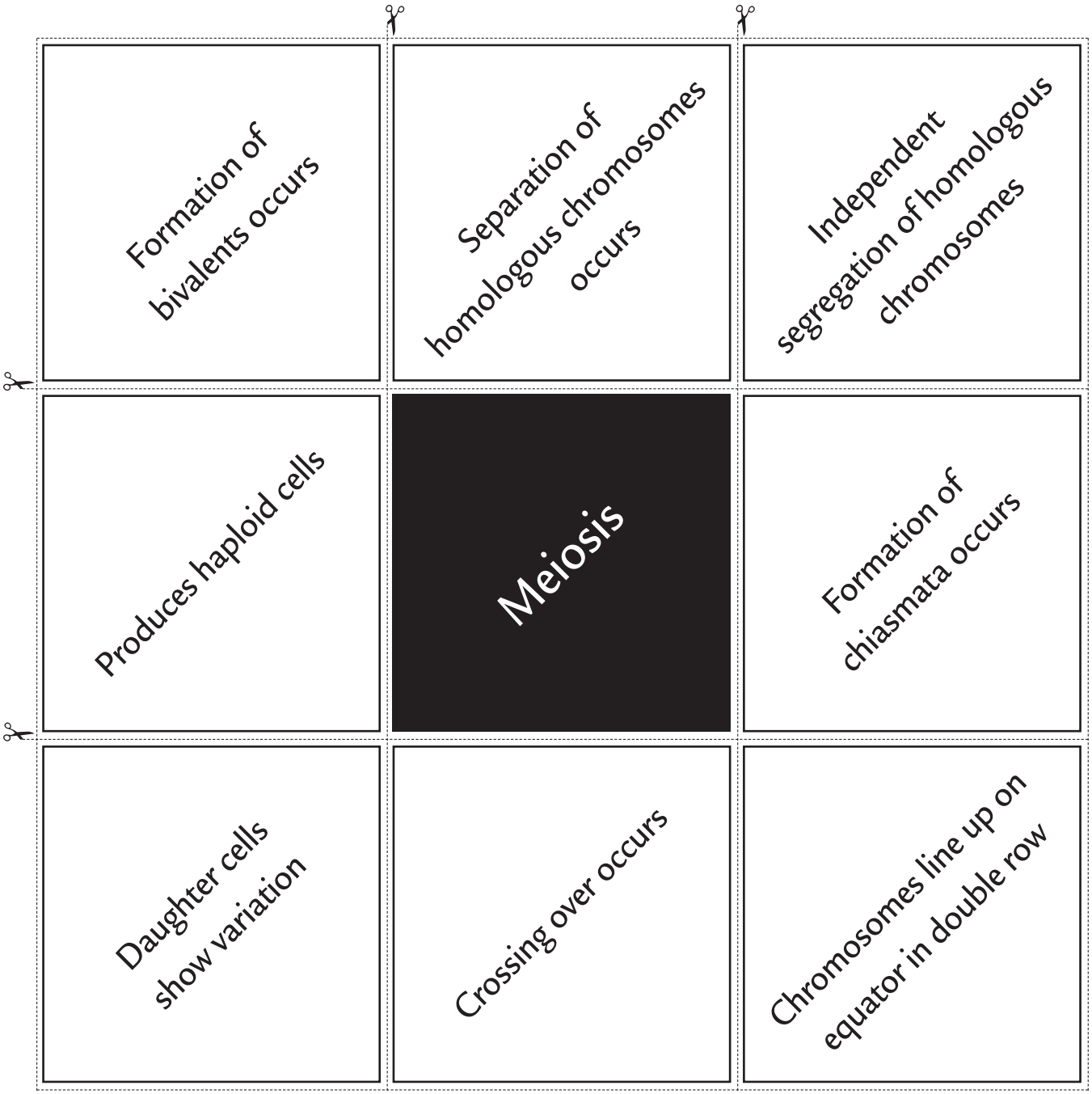
AS Diamonds: Cell division

2

G_1	S phase – DNA replication occurs	Synthesis of new organelles
Cell energy stores increase	Interphase	G_2
mRNA, tRNA and ribosomes synthesised	Cell growth occurs	Synthesis of new proteins



AS Diamonds: Cell division



AS Dominoes: Mitosis

2

Q	A
Late prophase shows...	...are now called chromosomes
Growth and repair...	...DNA replication occurs
Prophase is where chromosomes...	...organelles replicate
Centromeres join...	...is where chromosomes line up on the equator
Chromosomes are in two nuclei...	...is where spindle fibres contract
The last part of interphase is...	...chromosome as chromatids

AS Dominoes: Mitosis

Q	A
G1 phase is where...	...maintains the chromosome number
Clones form by...	...involves mitosis
Anaphase...	...prophase
Metaphase...	...daughter cells
S phase is where...	...equator
Centromere splits, so chromatids...	...at the end of telophase

AS Dominoes: Mitosis

A	Q
...two new cells	Clones show no...
...asexual reproduction	Nuclear envelope breaks down at the end of...
...G2	Mitosis results in...
...cytokinesis	Diploid cells divide to make diploid cells, which...
...move to poles	Centromere splits, pulling...
...the poles	Chromatids attach to the spindle at the...

AS Dominoes: Mitosis

Q	A
Spindle forms between…	…chromatids apart
Two new nuclear envelopes form before…	…chromosomes together
Cytokinesis results in…	…genetically identical cells
New genetically identical cells are…	…variation
Anaphase is where chromatids…	…condense

Teacher answers

A	Q
A ...chromatids apart	Q Spindle forms between...
A ...the poles	Q Chromatids attach to the spindle at the...
A ...equator	Q S phase is where...
A ...DNA replication occurs	Q Growth and repair...
A ...involves mitosis	Q Clones form by...
A ...asexual reproduction	Q Nuclear envelope breaks down at the end of...
A ...prophase	Q Anaphase...
A ...is where spindle fibres contract	Q Chromosomes are in two nuclei...
A ...at the end of telophase	Q Centromere splits, so chromatids...
A ...are now called chromosomes	Q Late prophase shows...
A ...chromosome as chromatids	Q The last part of interphase is...
A ...G2	Q Mitosis results in...
A ...genetically identical cells	Q Cytokinesis results in...
A ...two new cells	Q Clones show no...
A ...variation	Q New genetically identical cells are...
A ...daughter cells	Q Metaphase...
A ...is where chromosomes line up on the equator	Q Centromeres join...
A ...chromosomes together	Q Two new nuclear envelopes form before...
A ...cytokinesis	Q Diploid cells divide to make diploid cells, which...
A ...maintains the chromosome number	Q G1 phase is where...
A ...organelles replicate	Q Prophase is where chromosomes...
A ...condense	Q Anaphase is where chromatids...
A ...move to poles	Q Centromere splits, pulling...

AS Matching: Mitosis

2

Meioisis	Spindle apparatus	Chromatin
Prophase	Interphase	Cytokinesis
Mitosis	Haploid	Cell cycle

Metaphase	Anaphase	Chromosomes
Telophase	Diploid	Daughter cells
Centrioles	Division of the cell following telophase	Describes a cell in which there are two copies of each chromosome

DNA replication takes place	The cells produced as a result of the mitosis or meiosis of a parent cell	The pattern of events undertaken by dividing cells, including interphase and mitosis or meiosis
Cell division in which all daughter cells are genetically identical to the parent cell	The mixture of DNA and protein from which chromosomes are made	Chromosomes become visible, spindle apparatus forms, nucleolus disappears and nuclear envelope breaks down
The chromosomes reach the poles and a new nuclear envelope forms around each set; the chromosomes uncoil, once more becoming invisible	The spindle fibres contract, causing the two chromatids of each chromosome to separate and move to opposite poles of the cell	Made of chromatin (DNA and protein), and consisting of a pair of chromatids joined at the centromere

A set of fine tubular protein fibres that span the cell from pole to pole	Chromosomes arrange themselves on the equator of the spindle, attached by their centromeres	Cell division in which all daughter cells show genetic variation from each other and the parent cell; the daughter cells have only half the number of chromosomes of the parent cell
Describes a cell in which there is only one copy of each chromosome	Hollow cylindrical structures synthesising the fibres of the spindle apparatus, not found in plants	

Teacher answers

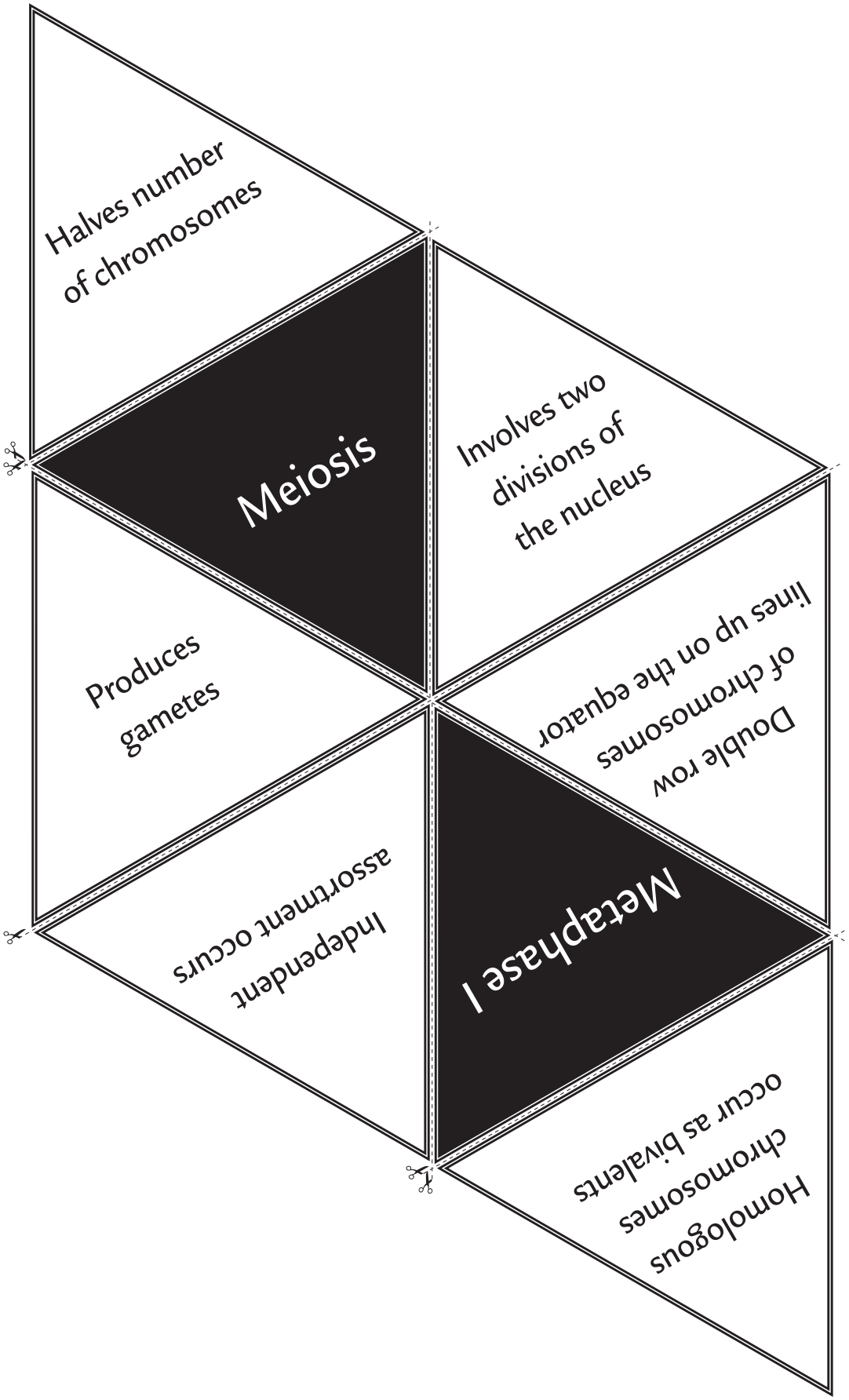
Interphase	DNA replication takes place
Prophase	Chromosomes become visible, spindle apparatus forms, nucleolus disappears and nuclear envelope breaks down
Metaphase	Chromosomes arrange themselves on the equator of the spindle, attached by their centromeres
Anaphase	The spindle fibres contract, causing the two chromatids of each chromosome to separate and move to opposite poles of the cell
Telophase	The chromosomes reach the poles and a new nuclear envelope forms around each set; the chromosomes uncoil, once more becoming invisible

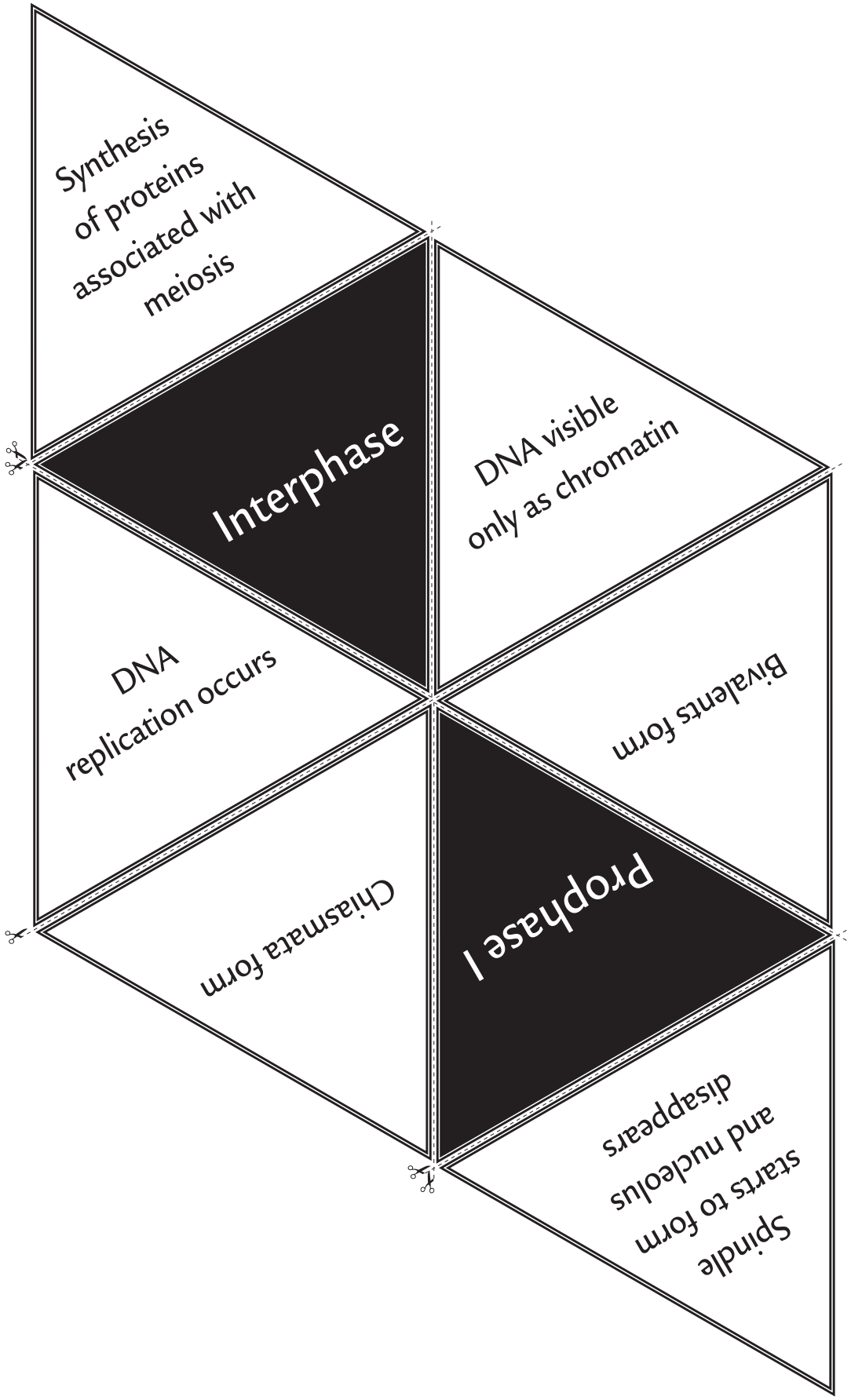
Centrioles	Hollow cylindrical structures synthesising the fibres of the spindle apparatus, not found in plants
Chromosomes	Made of chromatin (DNA and protein), and consisting of a pair of chromatids joined at the centromere
Spindle apparatus	A set of fine tubular protein fibres that span the cell from pole to pole
Cytokinesis	Division of the cell following telophase
Haploid	Describes a cell in which there is only one copy of each chromosome

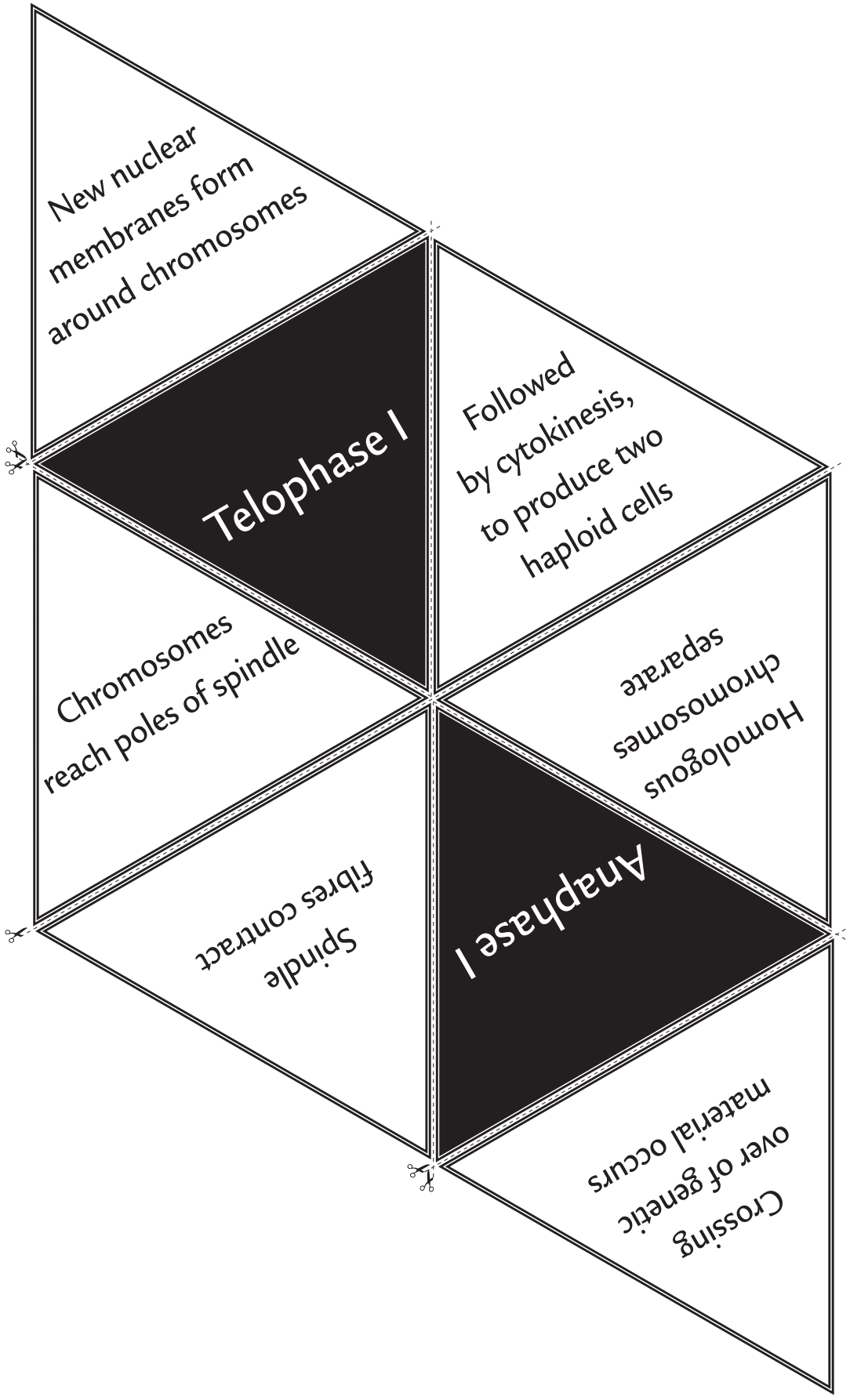
Diploid	Describes a cell in which there are two copies of each chromosome
Mitosis	Cell division in which all daughter cells are genetically identical to the parent cell
Meioisis	Cell division in which all daughter cells show genetic variation from each other and the parent cell; the daughter cells have only half the number of chromosomes of the parent cell
Daughter cells	The cells produced as a result of the mitosis or meiosis of a parent cell
Chromatin	The mixture of DNA and protein from which chromosomes are made
Cell cycle	The pattern of events undertaken by dividing cells, including interphase and mitosis or meiosis

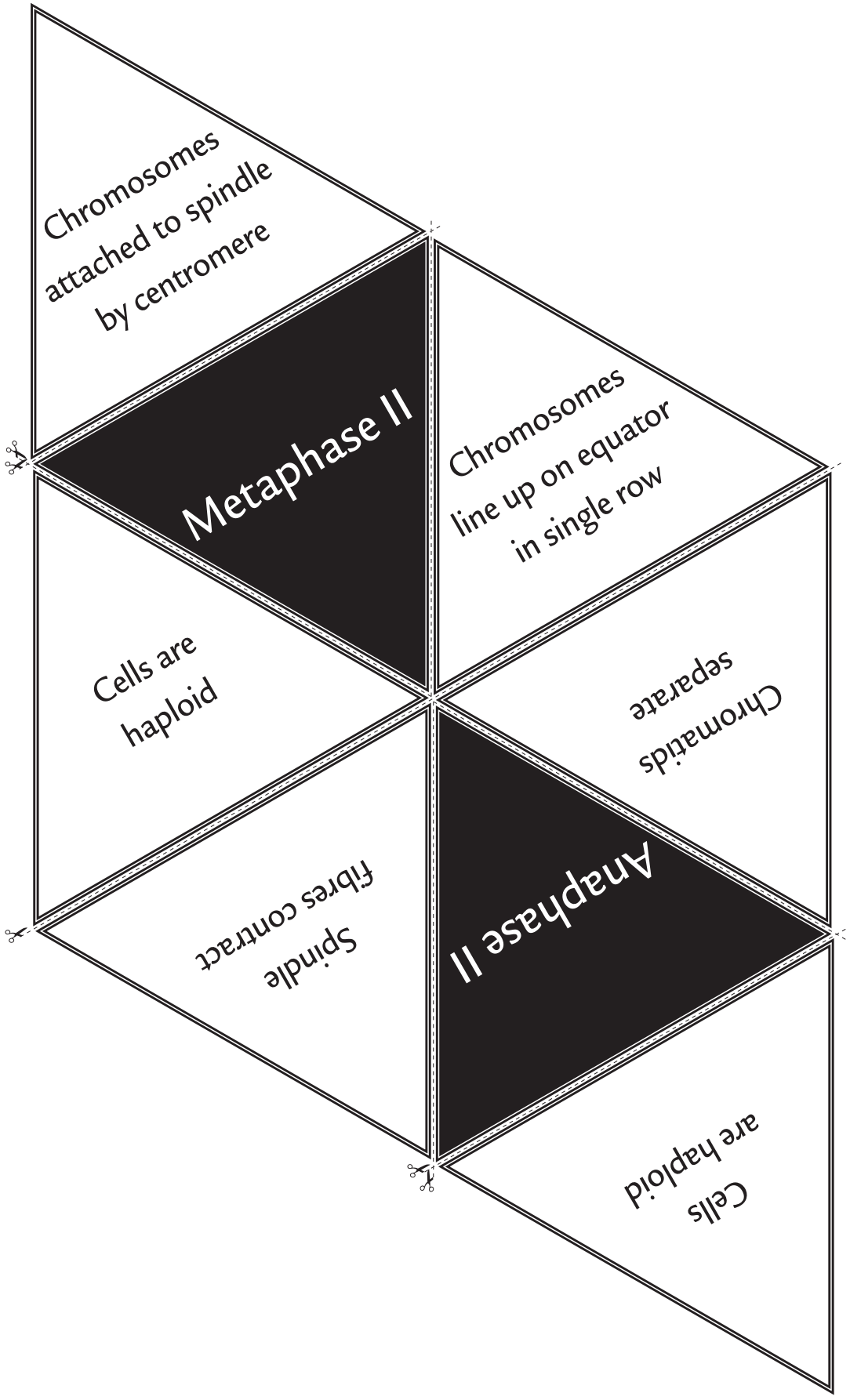
AS Triominoes: Meiosis

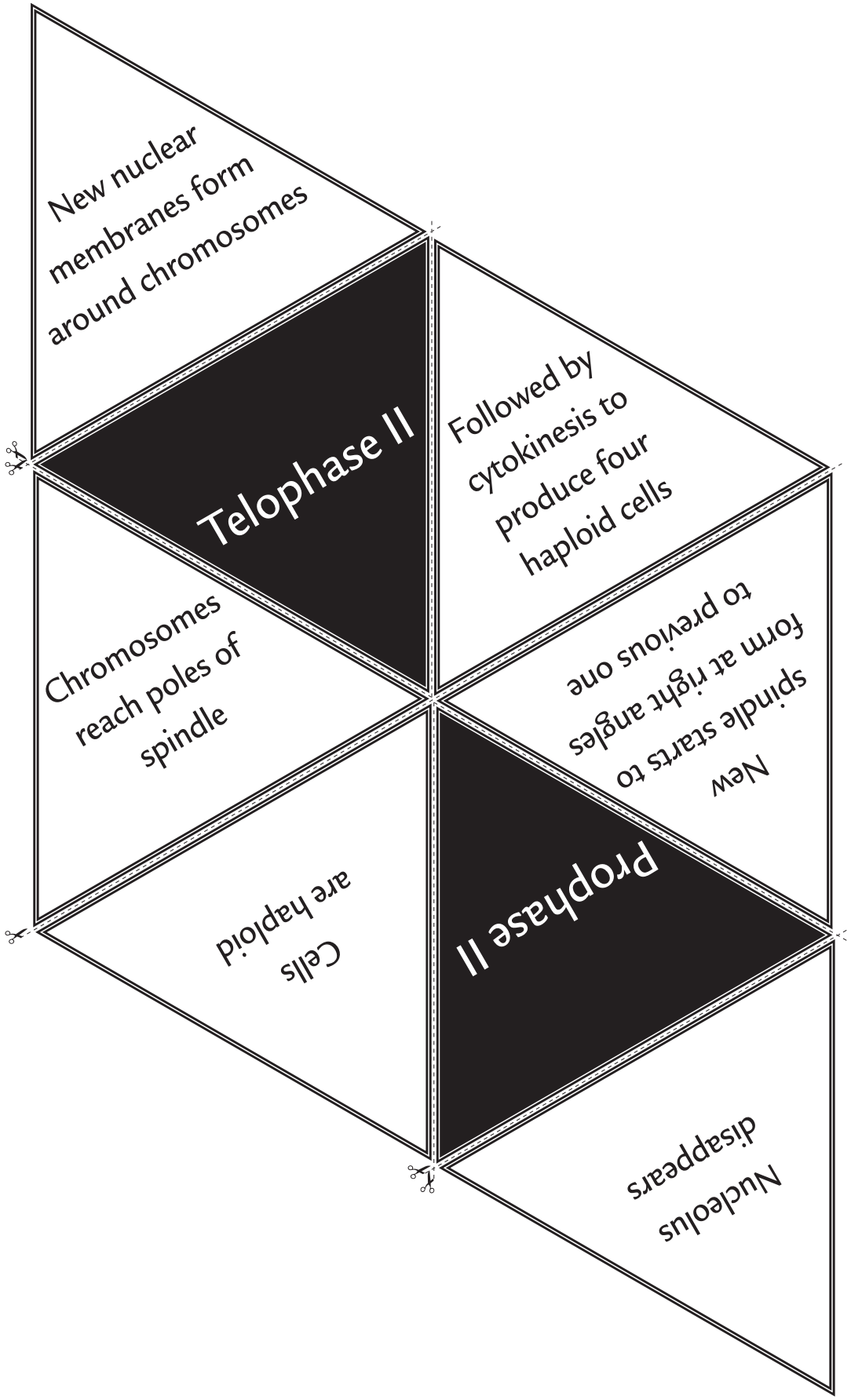
2

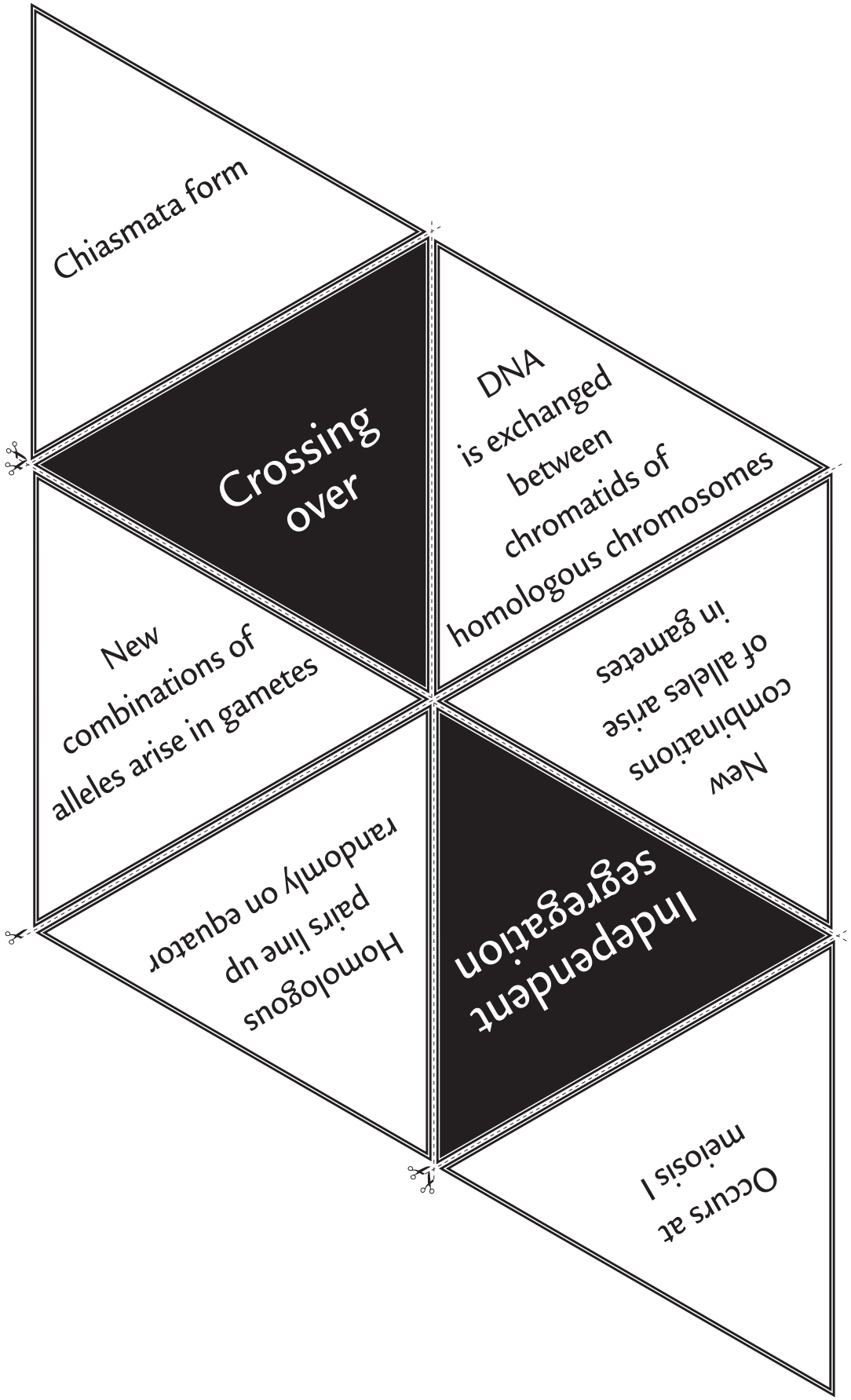












3 Biological molecules

- AS Bingo: Enzymes
- AS Dominoes: Enzymes
- AS Matching: Nucleic acids
- AS Play your cards right: Biological molecules

AS Bingo: Enzymes

3

Active site
Substrate
Tertiary structure
Hydrogen bonds
Alpha helix

Complementary
Lock and key
Activation energy
Catalyst
Competitive inhibitor

Enzyme–substrate complex
Induced fit
Non-competitive inhibitor
Optimum temperature
Denaturation

Active site
Substrate
Tertiary structure
Hydrogen bonds
Alpha helix

Complementary
Lock and key
Activation energy
Catalyst
Competitive inhibitor

Enzyme–substrate complex
Induced fit
Non-competitive inhibitor
Optimum temperature
Denaturation

Teacher definitions

Activation energy
The energy required to begin a chemical reaction, which can be reduced by enzymes

Active site
The part of the enzyme into which the substrate fits

Alpha helix
A coiled arrangement of the polypeptide chain

Catalyst
Any substance that speeds up the rate of a reaction

Competitive inhibitor
Slows down enzyme reactions by fitting into the active site

Complementary
The relationship between the active site and the substrate

Denaturation
Loss of the tertiary structure

Enzyme–substrate complex
Formed when a substrate fits into the active site

Hydrogen bonds
These help to maintain the three-dimensional shape of the enzyme

Induced fit
A theory that suggests that the active site moulds itself around the substrate

Lock and key
A theory that suggests that the active site is a rigid structure

Non-competitive inhibitor
This slows down enzyme reactions by fitting into a part of the enzyme other than the active site

Optimum temperature
The temperature at which an enzyme works fastest

Substrate
The molecule on which the enzyme acts

Tertiary structure
The three-dimensional shape of the enzyme

AS Dominoes: Enzymes

Q	A
A high substrate concentration…	…proteins
Loss of tertiary structure is…	…occurs at the optimum temperature
The optimum temperature of most enzymes…	…enzyme–substrate complexes
Substrates fit into…	…the active site moulds around the substrate
A non-competitive inhibitor has…	…denaturation
Increased kinetic energy of enzyme and substrate…	…above the optimum temperature

AS Dominoes: Enzymes

A	Q
…increases the rate of reaction	A low enzyme concentration…
…when a substrate fits into an active site	Changing pH can break…
…increases the number of collisions	Enzymes become saturated with substrates…
…increases the kinetic energy of enzyme and substrate	All enzymes are…
…changes the shape of an active site	Enzymes lower…
…at very high substrate concentrations	The best fit of enzyme and substrate…

AS Dominoes: Enzymes

A	Q
...is around 40–50°C	Competitive inhibitors have a...
...formation of enzyme–substrate complexes	Active sites and substrates are precisely complementary...
...fit into the active site	Hydrogen bonds break...
...biological catalysts	Competitive inhibitors reduce formation of...
...like locks and keys	Increasing the temperature...
...limits the rate of reaction	Enzyme–substrate complexes form...

AS Dominoes: Enzymes

Q A change to the shape of the active site reduces...

A ...a shape very different from the substrate

Q Enzymes are...

A ...the active site

Q Competitive inhibitors...

A ...shape similar to the substrate

Q A non-competitive inhibitor...

A ...some hydrogen and ionic bonds

Q An induced fit occurs when...

A ...activation energy

Teacher answers

A	Q
...formation of enzyme–substrate complexes	Active sites and substrates are precisely complementary...
...like locks and keys	Increasing the temperature...
...increases the kinetic energy of enzyme and substrate	All enzymes are...
...proteins	A high substrate concentration...
...increases the rate of reaction	A low enzyme concentration...
...limits the rate of reaction	Enzyme–substrate complexes form...
...when a substrate fits into an active site	Changing pH can break...
...some hydrogen and ionic bonds	A non-competitive inhibitor...
...changes the shape of an active site	Enzymes lower...
...activation energy	An induced fit occurs when...
...the active site moulds around the substrate	Substrates fit into...
...the active site	Enzymes are...
...biological catalysts	Competitive inhibitors reduce formation of...
...enzyme–substrate complexes	The optimum temperature of most enzymes...
...is around 40–50°C	Competitive inhibitors have a...
...shape similar to the substrate	Competitive inhibitors...
...fit into the active site	Hydrogen bonds break...
...above the optimum temperature	Increased kinetic energy of enzyme and substrate...
...increases the number of collisions	Enzymes become saturated with substrates...
...at very high substrate concentrations	The best fit of enzyme and substrate...
...occurs at the optimum temperature	Loss of tertiary structure is...
...denaturation	A non-competitive inhibitor has...
...a shape very different from the substrate	A change to the shape of the active site reduces...

AS Matching: Nucleic acids

3

Guanine	Adenine	Three
Base pair	Nucleotide	Two
Ribose	Purine	Cytosine

Complementary	Double helix	Antiparallel
Sugar–phosphate bonds	Pentose	Deoxyribose
Pyrimidine	Thymine	Hydrogen bonds

Polynucleotide	**Uracil**	A purine base complementary to thymine and uracil
A pyrimidine base complementary to adenine	General name for a five-carbon sugar	Chain of nucleotides
A pentose sugar found in DNA	A pentose sugar found in RNA	A pyrimidine base complementary to guanine

A molecule containing nitrogen and carbon, comprising one ring structure	Two complementary bases held together by hydrogen bonds, e.g. A–T and C–G	Number of hydrogen bonds between cytosine and guanine
A pyrimidine base found only in RNA	A purine base complementary to cytosine	A molecule containing nitrogen and carbon, comprising two ring structures
Weak bonds between complementary bases	The arrangement of complementary polynucleotides in the double helix	Monomer of nucleic acids

Shape of DNA molecules	Number of hydrogen bonds between adenine and thymine	The relationship between adenine and thymine, and between cytosine and guanine, for example
Strong bonds between adjacent nucleotides in a polynucleotide		

Teacher answers

Deoxyribose	A pentose sugar found in DNA
Ribose	A pentose sugar found in RNA
Purine	A molecule containing nitrogen and carbon, comprising two ring structures
Pyrimidine	A molecule containing nitrogen and carbon, comprising one ring structure
Complementary	The relationship between adenine and thymine, and between cytosine and guanine, for example
Hydrogen bonds	Weak bonds between complementary bases
Adenine	A purine base complementary to thymine and uracil
Thymine	A pyrimidine base complementary to adenine
Cytosine	A pyrimidine base complementary to guanine
Guanine	A purine base complementary to cytosine

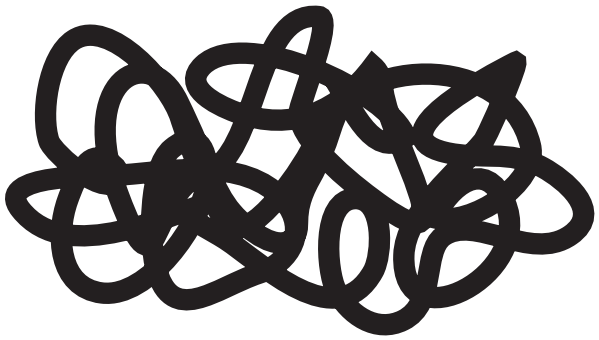
AS Matching: Nucleic acids

Uracil	A pyrimidine base found only in RNA
Nucleotide	Monomer of nucleic acids
Double helix	Shape of DNA molecules
Polynucleotide	Chain of nucleotides
Antiparallel	The arrangement of complementary polynucleotides in the double helix
Two	Number of hydrogen bonds between adenine and thymine
Sugar–phosphate bonds	Strong bonds between adjacent nucleotides in a polynucleotide
Three	Number of hydrogen bonds between cytosine and guanine
Pentose	General name for a five-carbon sugar
Base pair	Two complementary bases held together by hydrogen bonds, e.g. A–T and C–G

AS Play your cards right: Biological molecules

3

Carbohydrates



Proteins

Lipids

Nucleic acids

Teacher questions and answers

These are made of monomers called monosaccharides	Carbohydrates
These are not polymers	Lipids
DNA and RNA are examples of these	Nucleic acids
These are made up of one or more chains of amino acids	Proteins
These may have glycosidic bonds	Carbohydrates
These are made from monomers called nucleotides	Nucleic acids
These contain as many as 20 different monomers	Proteins
These include triglycerides	Lipids
These include glucose and starch	Carbohydrates
These contain nitrogen and phosphorus	Nucleic acids
These have peptide bonds	Proteins
These contain a nitrogenous base	Nucleic acids
These all have a primary structure	Proteins
These include cellulose	Carbohydrates
These contain a sugar–phosphate backbone	Nucleic acids
These may contain fatty acids	Lipids
Each type of these contains up to four different monomers	Nucleic acids
These contain at least one polypeptide	Proteins
These contain purines and pyrimidines	Nucleic acids
These may contain long hydrocarbon chains	Lipids
These may have hydrogen and ionic bonds	Proteins
These include haemoglobin	Proteins
These may include uracil and guanine	Nucleic acids
These may contain an alpha-helix structure	Proteins
These are not found in the plasma (cell) membrane	Nucleic acids

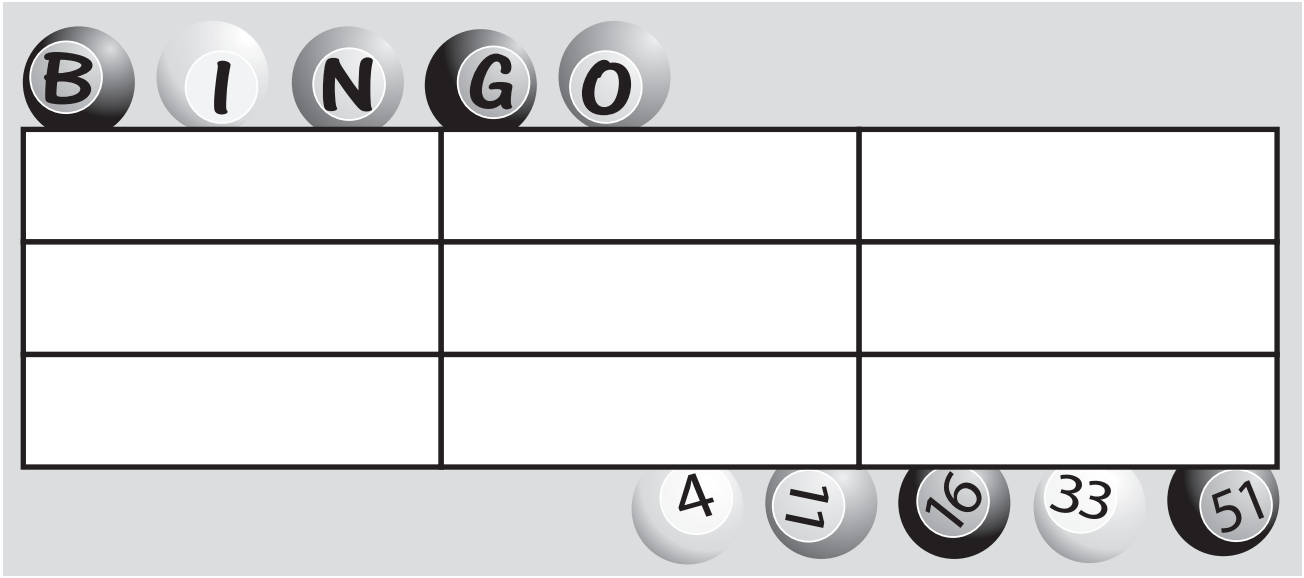
4 Transport and exchange

- AS Bingo: Heart and circulation
- AS Diamonds: Cardiac cycle
- AS Dominoes: Heart and circulation
- AS Dominoes: Membranes
- AS Jigsaw: Transport across membranes
- AS Matching: Heart and heart disease

AS Bingo: Heart and circulation

4

Right atrium
Left ventricle
Aorta
Pulmonary arteries
Left atrium
Vena cava
Right ventricle
Semilunar valves
Atrioventricular valves
Systole
Diastole
Oxygenated
Deoxygenated
Cardiac cycle
Pulmonary veins



Right atrium
Left ventricle
Aorta
Pulmonary arteries
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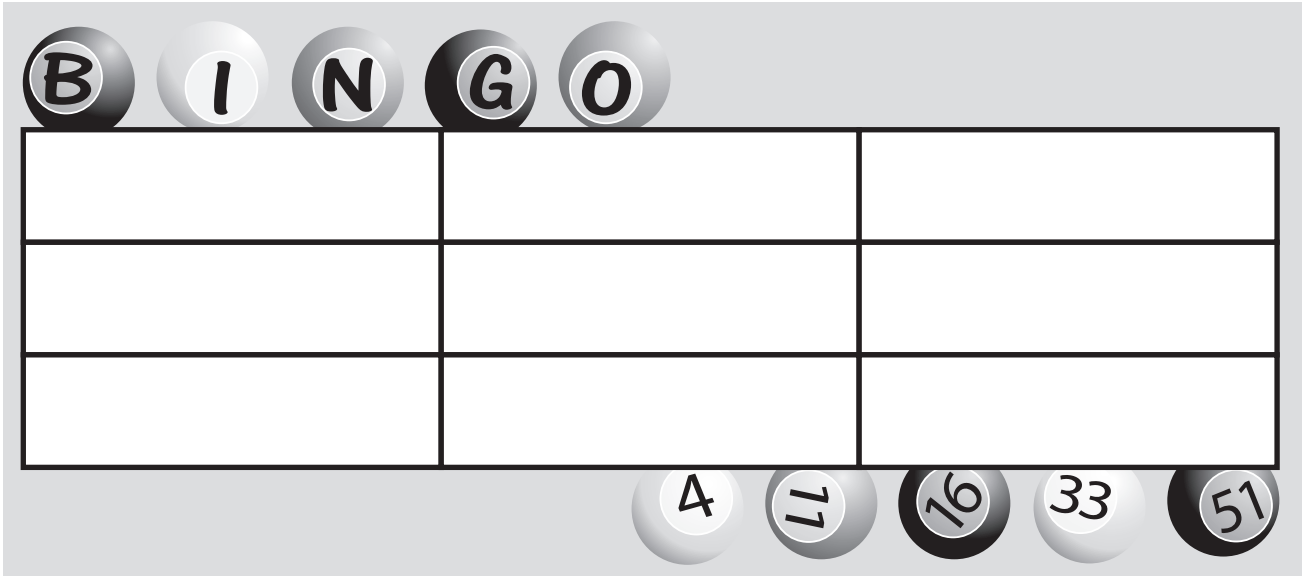
Vena cava
Right ventricle
Semilunar valves
Atrioventricular valves
Systole
Diastole
Oxygenated
Deoxygenated
Cardiac cycle
Pulmonary veins



Teacher definitions

Aorta
This takes oxygenated blood away from the heart

Atrioventricular valves
These prevent backflow of blood from the ventricles

Cardiac cycle
The events occurring in a single heart beat

Deoxygenated
Type of blood flowing through the right side of the heart

Diastole
Relaxation of the cardiac muscle

Left atrium
This receives blood from the pulmonary veins

Left ventricle
This part of the heart has the thickest muscular walls

Oxygenated
Type of blood flowing through the left side of the heart

Pulmonary arteries
Take deoxygenated blood from the heart to the lungs

Pulmonary veins
Carry oxygenated blood to the heart

Right atrium
This receives blood from the vena cava

Right ventricle
Where blood flows to after leaving the right atrium

Semilunar valves
Prevent backflow of blood from the arteries into the heart

Systole
The contraction of cardiac muscle

Vena cava
The main vein

AS Diamonds: Cardiac cycle

Ventricles relaxed	Atria fill with blood	Atria relaxed
Resting period	**Diastole**	Atrioventricular valves closed initially
Aortic pressure greater than ventricular pressure	Rising atrial pressure opens atrioventricular valves	Semilunar valves closed

AS Dominoes: Heart and circulation

A	Q
Left atrium	Which tissue spreads impulses up from the base of the ventricles?
Oxygenated	What name is given to the left atrioventricular valve?
Deoxygenated	Which structures contract to tighten the valve tendons?
Myogenic	Which chamber of the heart receives oxygenated blood from the lungs?
Right atrium	Which artery receives blood from the left ventricle?
Systemic	Which structure in the right atrium initiates the heart beat?

AS Dominoes: Heart and circulation

A	Q
Systole	Which circuit of the double circulation flows through the left side of the heart?
Coronary arteries	Which type of valve is found in the aorta?
Right ventricle	Which chamber of the heart receives deoxygenated blood via the vena cava?
Diastole	What type of blood is found in the left side of the heart?
Tricuspid valve	Which term describes all the events of a single heart beat?
Cardiac cycle	Which term describes the blood in the right side of the heart?

AS Dominoes: Heart and circulation

A	Q
Valve tendons	Which vessel carries deoxygenated blood to the lungs?
Atrioventricular valves	During which phase of the cardiac cycle is cardiac muscle contracted?
Left ventricle	Which structure delays the passage of impulses to the ventricles?
Aorta	During which phase of the cardiac cycle is the cardiac muscle relaxed?
Pulmonary artery	Which type of valves separate the atria and the ventricles?
Sinoatrial node	What is the name of the right atrioventricular valve?

AS Dominoes: Heart and circulation

A	Q
Purkyne fibres	Which structures prevent the atrioventricular valves from inverting?
Bicuspid valve	Which part of the heart separates the left side from the right side?
Papillary muscles	Which chamber of the heart pumps blood into the pulmonary artery?
Atrioventricular node (AVN)	Which term means that the cardiac muscle produces impulses to stimulate its own contraction?
Septum	Which vessels supply oxygenated blood to the cardiac muscle?
Semilunar valve	Which chamber of the heart has the thickest muscular walls?

Teacher answers

A Right ventricle	Q Which chamber of the heart receives deoxygenated blood via the vena cava?
A Right atrium	Q Which artery receives blood from the left ventricle?
A Aorta	Q During which phase of the cardiac cycle is the cardiac muscle relaxed?
A Diastole	Q What type of blood is found in the left side of the heart?
A Oxygenated	Q What name is given to the left atrioventricular valve?
A Bicuspid valve	Q Which part of the heart separates the left side from the right side?
A Septum	Q Which vessels supply oxygenated blood to the cardiac muscle?
A Coronary arteries	Q Which type of valve is found in the aorta?
A Semilunar valve	Q Which chamber of the heart has the thickest muscular walls?
A Left ventricle	Q Which structure delays the passage of impulses to the ventricles?
A Atrioventricular node (AVN)	Q Which term means that the cardiac muscle produces impulses to stimulate its own contraction?
A Myogenic	Q Which chamber of the heart receives oxygenated blood from the lungs?
A Left atrium	Q Which tissue spreads impulses up from the base of the ventricles?
A Purkyne fibres	Q Which structures prevent the atrioventricular valves from inverting?
A Valve tendons	Q Which vessel carries deoxygenated blood to the lungs?
A Pulmonary artery	Q Which type of valves separate the atria and the ventricles?
A Atrioventricular valves	Q During which phase of the cardiac cycle is cardiac muscle contracted?
A Systole	Q Which circuit of the double circulation flows through the left side of the heart?
A Systemic	Q Which structure in the right atrium initiates the heart beat?
A Sinoatrial node	Q What is the name of the right atrioventricular valve?
A Tricuspid valve	Q Which term describes all the events of a single heart beat?
A Cardiac cycle	Q Which term describes the blood in the right side of the heart?
A Deoxygenated	Q Which structures contract to tighten the valve tendons?
A Papillary muscles	Q Which chamber of the heart pumps blood into the pulmonary artery?

AS Dominoes: Membranes

A …down a concentration gradient

Q Large polar molecules diffuse…

A …ATP

Q A low surface area of membrane…

A …passive processes

Q Osmosis occurs down…

A …a bilayer

Q Glycoproteins are…

A …through carrier proteins

Q Active transport requires…

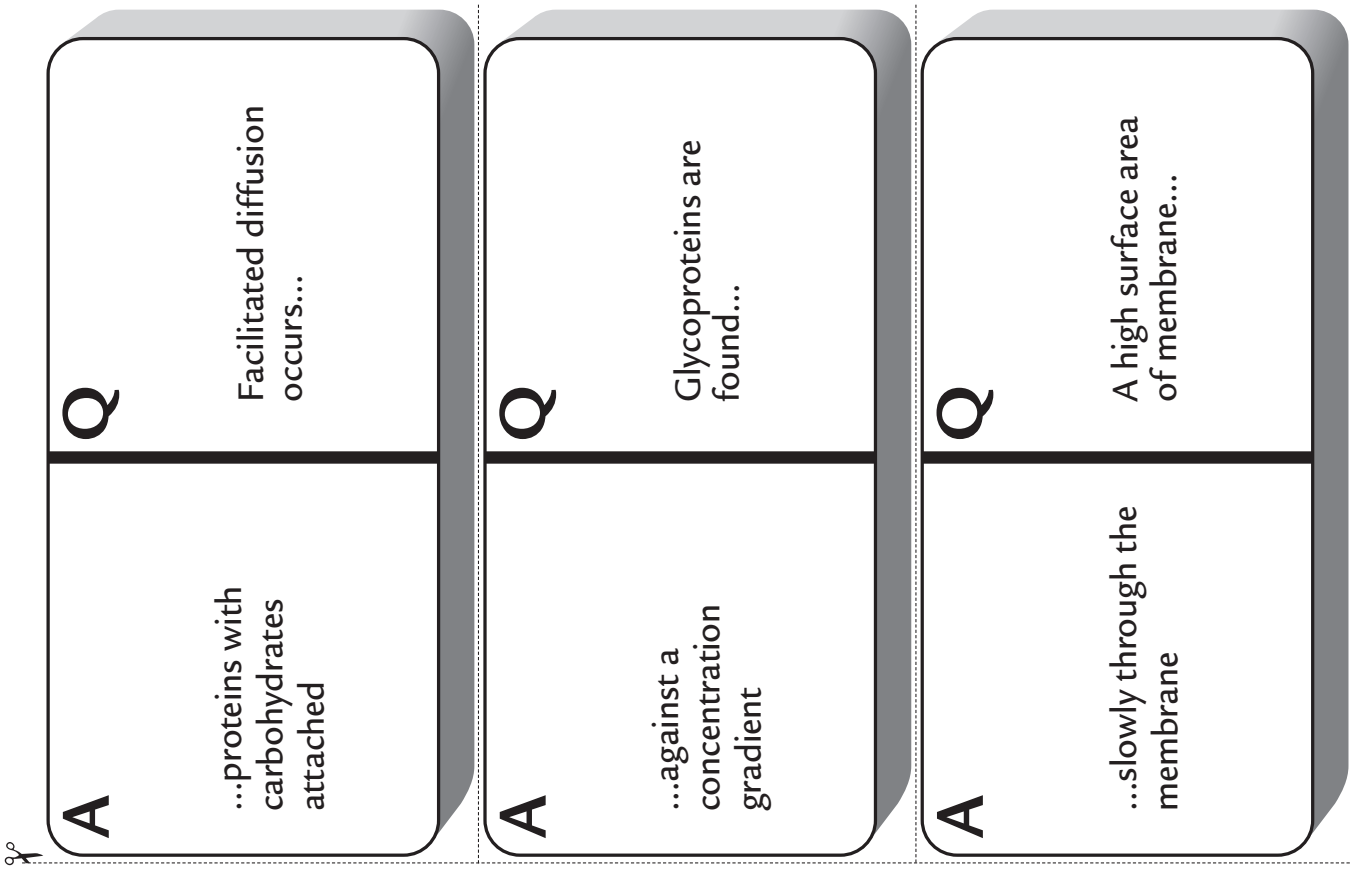
A …on the surface of membranes

Q Osmosis is the…

AS Dominoes: Membranes

Q	A
Phospholipids form...	...through the bilayer
Active transport occurs...	...a water potential gradient
Simple diffusion occurs...	...in the bilayer
kPa are the...	...increases rate of diffusion
Intrinsic proteins are found...	...on the surface of membranes
Fatty acid chains form...	...rapidly through the membrane

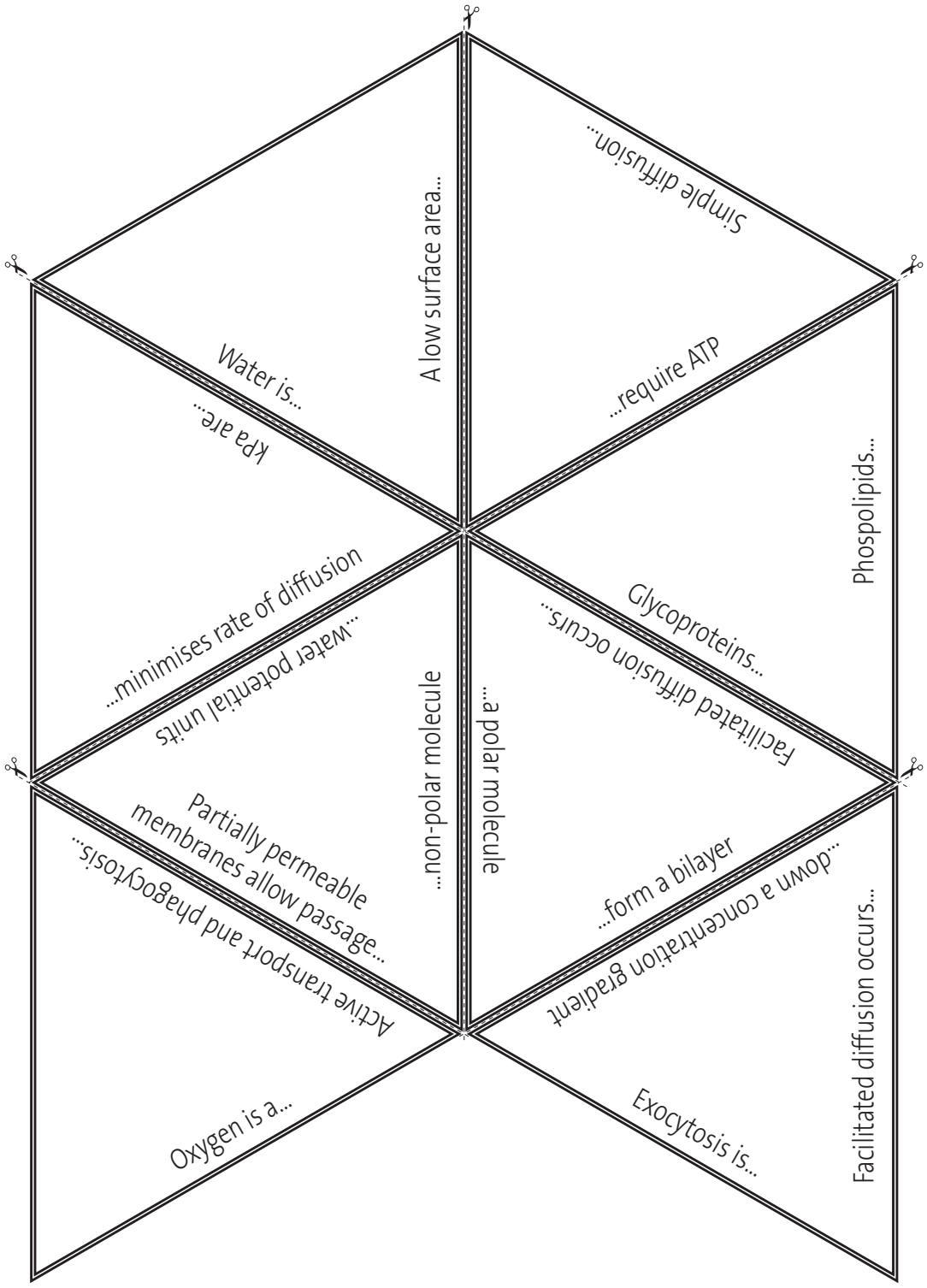
	Q	A
1	Extrinsic proteins are found…	…through hydrophilic channels
2	Phosphate and glycerol form…	…units of water potential
3	Facilitated diffusion occurs…	…hydrophobic tails
4	Diffusion and osmosis are…	…movement of water only
5	Active transport occurs…	…hydrophilic heads
6	Small, non-polar molecules diffuse…	…decreases rate of diffusion

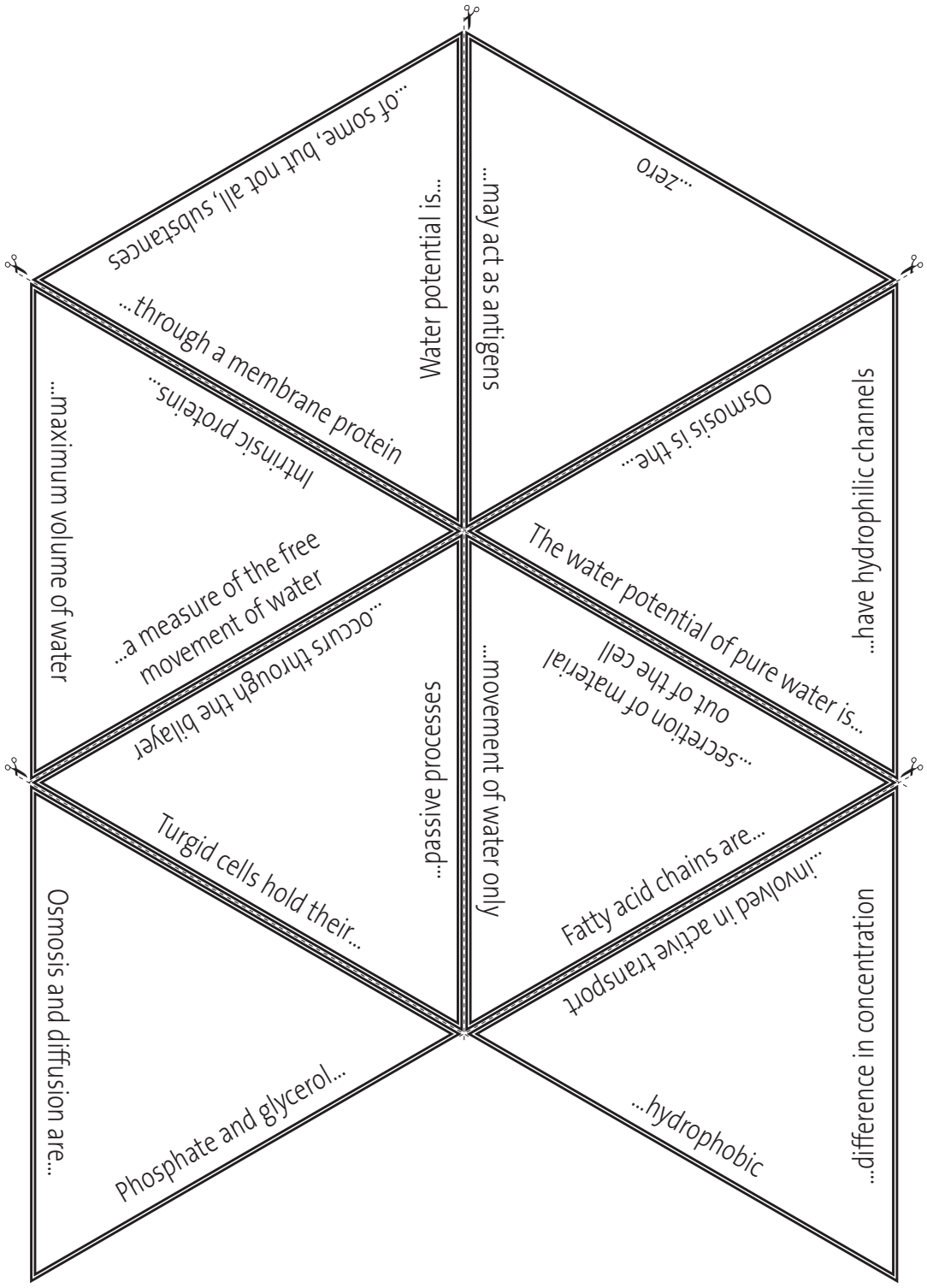


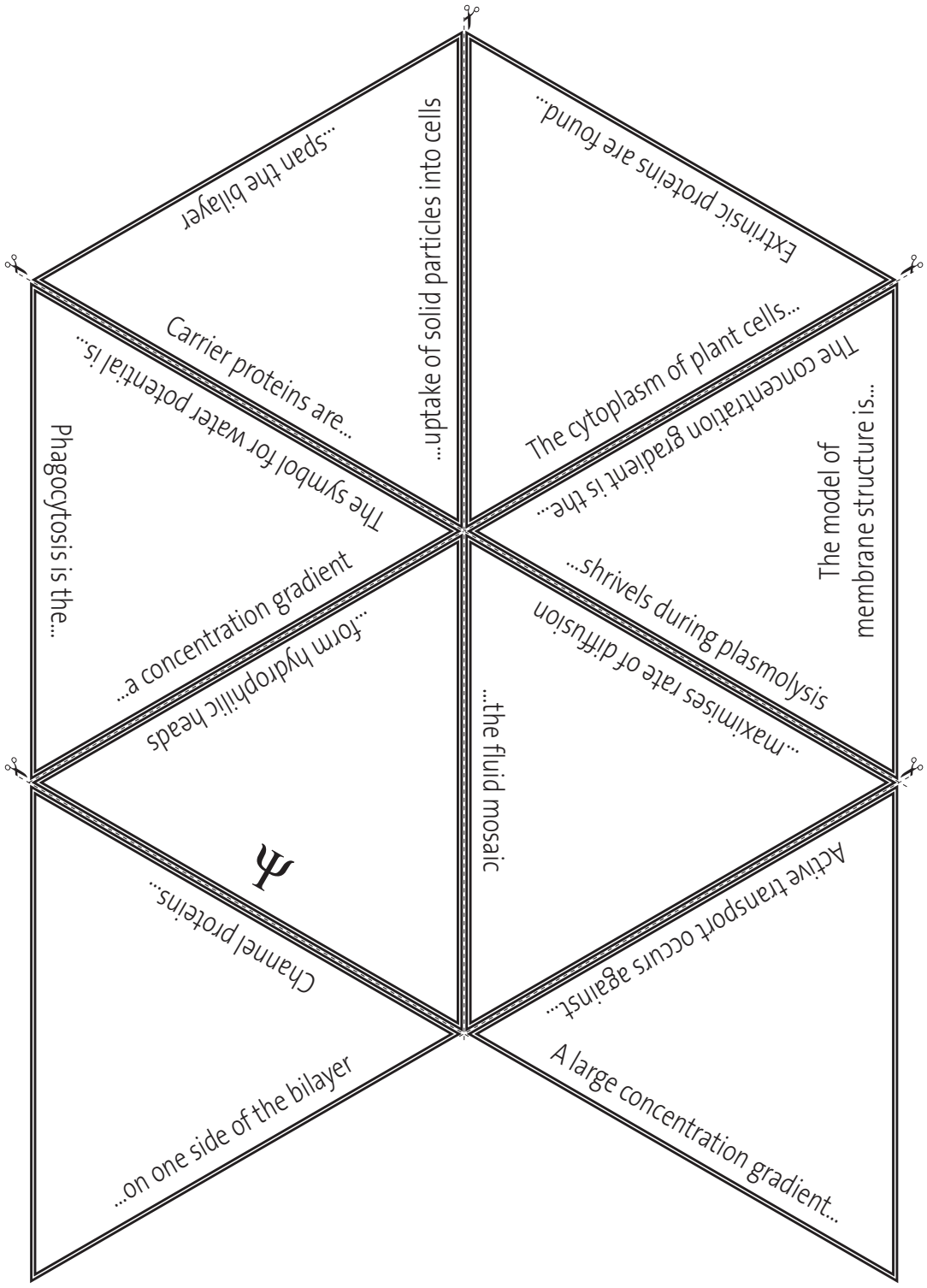
Teacher answers

A	Q
...a water potential gradient	Active transport occurs...
...through carrier proteins	Active transport requires...
...ATP	A low surface area of membrane...
...decreases rate of diffusion	Small, non-polar molecules diffuse...
...rapidly through the membrane	Fatty acid chains form...
...hydrophobic tails	Facilitated diffusion occurs...
...through hydrophilic channels	Extrinsic proteins are found...
...on the surface of membranes	Intrinsic proteins are found...
...in the bilayer	Simple diffusion occurs...
...through the bilayer	Phospholipids form...
...a bilayer	Glycoproteins are...
...proteins with carbohydrates attached	Facilitated diffusion occurs...
...down a concentration gradient	Large polar molecules diffuse...
...slowly through the membrane	A high surface area of membrane...
...increases rate of diffusion	kPa are the...
...units of water potential	Phosphate and glycerol form...
...hydrophilic heads	Active transport occurs...
...against a concentration gradient	Glycoproteins are found...
...on the surface of membranes	Osmosis is the...
...movement of water only	Diffusion and osmosis are...
...passive processes	Osmosis occurs down...

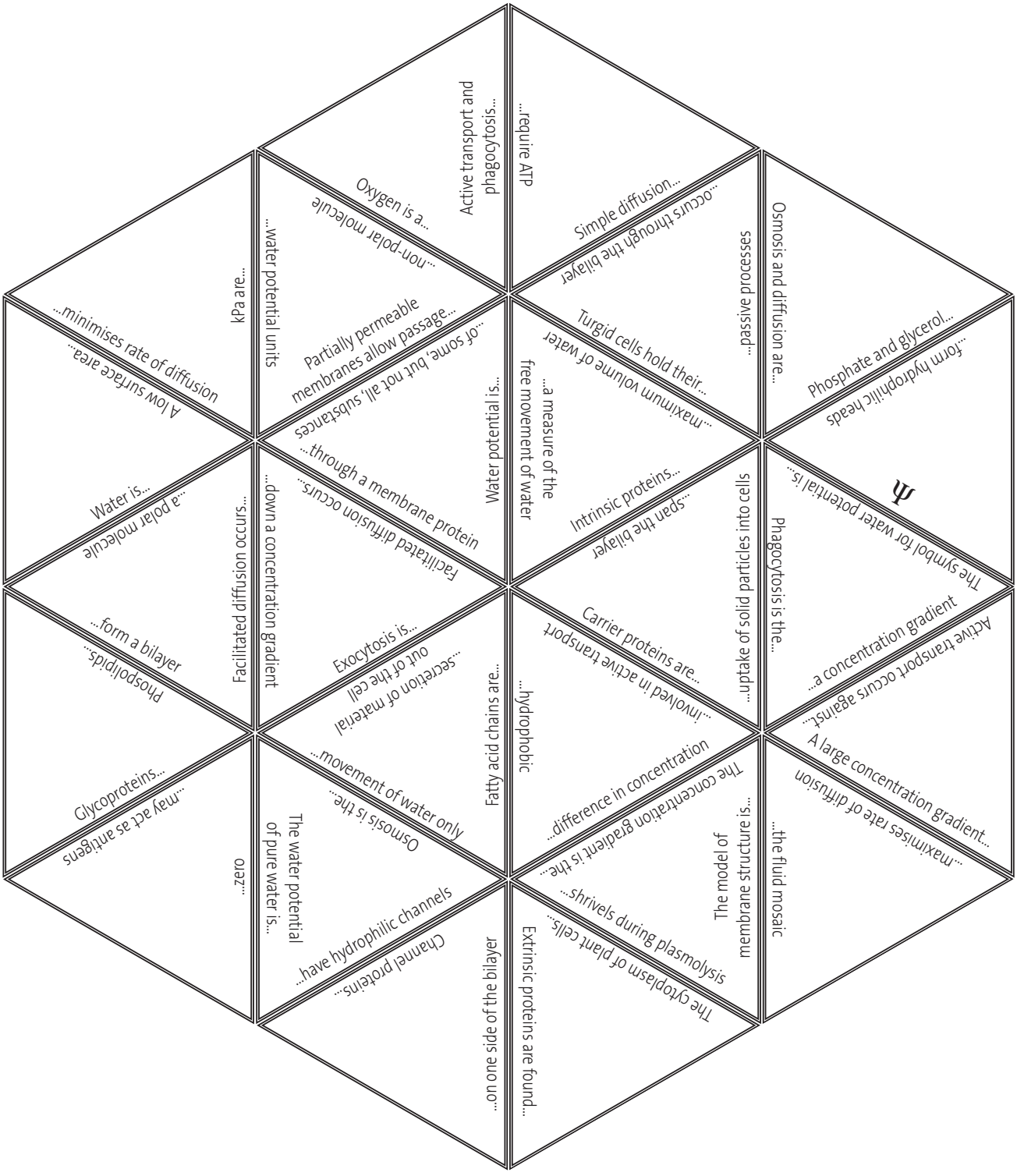
AS Jigsaw: Transport across membranes







Teacher answers



AS Matching: Heart and heart disease

4

Aorta	Semilunar valves	Atrio-ventricular valves
Left atrium	Left ventricle	Right atrium
Cholesterol	Platelets	Myocardial infarction

Endothelium	Angioplasty	Cardiac muscle
Oxygenated blood	Right ventricle	Vena cava
Pulmonary artery	Deoxygenated blood	Atheroma

Pulmonary veins	**Coronary artery**	Blood with the highest carbon dioxide concentration
Supplies oxygenated blood to heart muscle	Heart chamber receiving blood from the lungs	Inflation of a tiny balloon to widen the lumen of a coronary artery affected by atheroma
Cell fragments that collect over an atheroma, forming a blood clot	Main artery carrying oxygenated blood away from the heart	Blood vessel carrying deoxygenated blood to the lungs

Vessels delivering oxygenated blood to the heart	Main vein	Receives blood from right atrium
Heart chamber receiving deoxygenated blood	Heart chamber with the thickest muscular walls	Non-fatiguing tissue from which the bulk of the heart is formed
Fatty substance that is a major component of atheroma	Damage to heart muscle caused by blocked blood flow – a heart attack	Deposit in wall of artery, narrowing lumen of coronary artery

Prevent backflow of blood into the heart

Examples include the bicuspid and tricuspid valves

Lining of arteries that can be damaged by chemicals in cigarette smoke and by high blood pressure

Travels through the left side of the heart

Teacher answers

Aorta	Main artery carrying oxygenated blood away from the heart
Pulmonary artery	Blood vessel carrying deoxygenated blood to the lungs
Pulmonary veins	Vessels delivering oxygenated blood to the heart
Vena cava	Main vein
Right atrium	Heart chamber receiving deoxygenated blood
Left atrium	Heart chamber receiving blood from the lungs
Left ventricle	Heart chamber with the thickest muscular walls
Right ventricle	Receives blood from right atrium
Semilunar valves	Prevent backflow of blood into the heart
Atrio-ventricular valves	Examples include the bicuspid and tricuspid valves

AS Matching: Heart and heart disease

Cardiac muscle	Non-fatiguing tissue from which the bulk of the heart is formed
Oxygenated blood	Travels through the left side of the heart
Deoxygenated blood	Blood with the highest carbon dioxide concentration
Atheroma	Deposit in wall of artery, narrowing lumen of coronary artery
Endothelium	Lining of arteries that can be damaged by chemicals in cigarette smoke and by high blood pressure
Cholesterol	Fatty substance that is a major component of atheroma
Coronary artery	Supplies oxygenated blood to heart muscle
Platelets	Cell fragments that collect over an atheroma, forming a blood clot
Myocardial infarction	Damage to heart muscle caused by blocked blood flow — a heart attack
Angioplasty	Inflation of a tiny balloon to widen the lumen of a coronary artery affected by atheroma

5 Genes and DNA technology

- A2 Bingo: DNA technology
- AS/A2 Matching: Genetics
- A2 Sequencing: DNA fingerprinting/electrophoresis
- A2 Sequencing: Protein synthesis
- A2 Sequencing: Recombinant DNA technology

A2 Bingo: DNA technology

5

DNA polymerase
DNA ligase
Restriction enzyme
Genome
Electrophoresis
PCR
Plasmid
Marker gene
Clones
Sticky end
Gene probe
Primer
Reverse transcriptase
Recombinant DNA
Somatic gene therapy
Germ line gene therapy
Oncogene
Tumour suppressor gene
Mutation
Semi-conservative replication

DNA polymerase
DNA ligase
Restriction enzyme
Genome
Electrophoresis
PCR
Plasmid
Marker gene
Clones
Sticky end
Gene probe
Primer
Reverse transcriptase
Recombinant DNA
Somatic gene therapy
Germ line gene therapy
Oncogene
Tumour suppressor gene
Mutation
Semi-conservative replication

Teacher definitions

Clones
Genetically identical cells

DNA polymerase
Enzyme that joins nucleotides in DNA synthesis

DNA ligase
Enzyme that joins lengths of DNA in gene technology

Electrophoresis
Separation technique

Gene probe
Locates a specific gene

Genome
The genetic make up of an organism

Germ line gene therapy
Altering DNA in gametes

Marker gene
Used to identify transformed cells

Mutation
Change in DNA in a cell

Oncogene
A gene that stimulates cells to divide too quickly

PCR
Process used to amplify DNA outside the body

Plasmid
A vector in gene technology

Primer
Marks region of DNA to be amplified

Recombinant DNA
DNA from more than one organism

Restriction enzyme
Enzyme that cuts at specific base sequences

Reverse transcriptase
Enzyme that produces RNA from DNA

Semi-conservative replication
Method by which DNA is copied

Somatic gene therapy
Altering DNA in non-sex cells

Sticky end
Single-stranded section of DNA

Tumour suppressor gene
Gene that prevents cells dividing too rapidly

AS/A2 Matching: Genetics

5

Heterogametic sex	F2 generation	Allele
Dominant	Homozygous	Test cross
Homogametic sex	F1 generation	Dihybrid inheritance

Phenotype	Parentals	Sex linkage
Multiple alleles	Genotype	Locus
Gene	Reciprocal cross	Sex chromosomes

Monohybrid inheritance	Heterozygous	Recessive
Pure breeding	Codominance	Phenotypic ratio
The allele that, if present, will be switched on/expressed	Showing all possible outcomes if all the gamete types from both parents are allowed to cross	An organism homozygous for a particular gene — if self fertilised, it will always produce offspring identical to itself

Genes carried on the sex chromosomes; inheritance of these genes differs in males and females	Human males; their sperm contain either an X or a Y chromosome	A way of identifying unknown genotypes – often by crossing with a homozygous recessive genotype
A piece of DNA that codes for a polypeptide and determines a specific characteristic	A variant form of a gene	An allele that will only be expressed when homozygous, i.e. no other types of allele are present
A genetic cross carried out involving two genes, often controlling more than one phenotypic characteristic	The original organisms involved in a genetic cross	The first set of offspring from a genetic cross

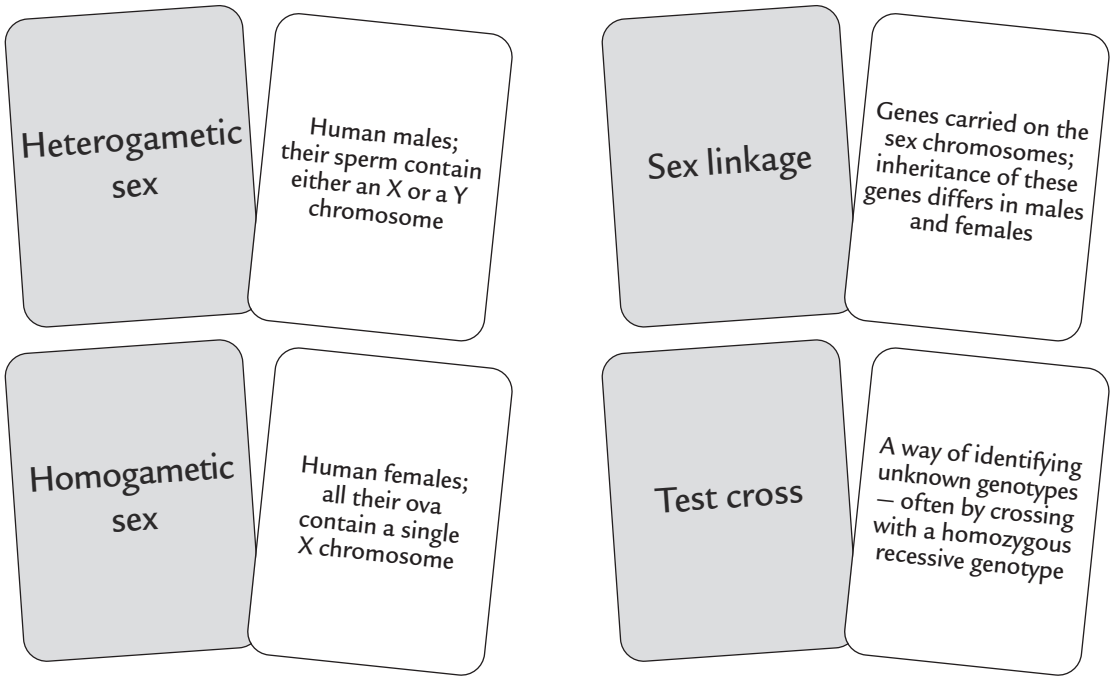
Human females; all their ova contain a single X chromosome	Where a gene has more than two allele types – although only two can be present in any one organism	In humans, females have two X chromosomes; males have XY
The second set of offspring from a genetic cross – obtained by interbreeding the F1 generation	The specific location of a gene on a chromosome	A genetic cross carried out for only one gene, controlling one phenotypic characteristic
The organism's cells have identical alleles for a gene	The organism's cells have different alleles for a gene	The expression of the genotype and its interaction with the environment

The genetic constitution of an organism — the combination of alleles in an individual's DNA	The phenotypes and the relative proportions of them resulting from a particular cross	In heterozygous individuals, both alleles are expressed in the phenotype

Teacher answers

Gene	A piece of DNA that codes for a polypeptide and determines a specific characteristic
Allele	A variant form of a gene
Genotype	The genetic constitution of an organism — the combination of alleles in an individual's DNA
Phenotype	The expression of the genotype and its interaction with the environment
Homozygous	The organism's cells have identical alleles for a gene
Heterozygous	The organism's cells have different alleles for a gene
Dominant	The allele that, if present, will be switched on/expressed
Recessive	An allele that will only be expressed when homozygous, i.e. no other types of allele are present
Locus	The specific location of a gene on a chromosome
Pure breeding	An organism homozygous for a particular gene — if self fertilised, it will always produce offspring identical to itself

Monohybrid inheritance	A genetic cross carried out for only one gene, controlling one phenotypic characteristic
Dihybrid inheritance	A genetic cross carried out involving two genes, often controlling more than one phenotypic characteristic
Reciprocal cross	Showing all possible outcomes if all the gamete types from both parents are allowed to cross
Parentals	The original organisms involved in a genetic cross
F1 generation	The first set of offspring from a genetic cross
F2 generation	The second set of offspring from a genetic cross — obtained by interbreeding the F1 generation
Phenotypic ratio	The phenotypes and the relative proportions of them resulting from a particular cross
Codominance	In heterozygous individuals, both alleles are expressed in the phenotype
Multiple alleles	Where a gene has more than two allele types — although only two can be present in any one organism
Sex chromosomes	In humans, females have two X chromosomes; males have XY



A2 Sequencing: DNA fingerprinting/electrophoresis

5

1 **Start card** DNA sample is cloned using PCR

2 DNA is heated to high temperature so that hydrogen bonds between base pairs break

3 DNA is cooled and primers are added

4 DNA polymerase and free nucleotides are added

5 Nucleotides pair up to single strands of DNA by complementary base pairing

6 DNA polymerase joins free nucleotides together

7 Cycle is repeated until multiple copies of DNA are cloned

8 Cloned DNA is cut into fragments of different lengths using different restriction enzymes

9 Fragments are placed into wells and gel electrophoresis is carried out

10 DNA fragments separate according to size and move towards anode

11 Position of fragments is compared with other samples obtained

12 Matching bands can be used to identify crime suspects, to give a medical diagnosis, and in paternity cases

A2 Sequencing: Protein synthesis

5

1 **Start card** Complementary DNA strands separate as the result of hydrogen bonds between base pairs being broken

2 This exposes the bases along each strand

3 Free RNA nucleotides with the bases A, C, G and U are attracted to their complementary bases on one of the exposed strands of DNA

4 The enzyme RNA polymerase moves along the DNA, adding one complementary RNA nucleotide at a time to the newly unwound portion of DNA; in this way the DNA acts as a template against which mRNA is constructed

5 The mRNA detaches from the DNA and the double helix reforms as its complementary base pairs join by hydrogen bonding

6 The mRNA enters the cytoplasm by passing through a pore in the nuclear envelope

7 A ribosome becomes attached to the mRNA

8 The complementary anticodon of a tRNA is attracted to the first codon on the mRNA

9 Hydrogen bonds form between the codon and anticodon

10 The second codon also attracts its complementary anticodon

11 A peptide bond forms between the two amino acids

12 A dipeptide is formed

13 The first tRNA leaves the ribosome to join with another molecule of its specific amino acid

14 The ribosome now moves along the mRNA by one codon

15 A third tRNA brings its specific amino acid to the ribosome

16 This process is repeated to build up a polypeptide chain

17 The ribosome continues along the mRNA until it reaches a stop codon

A2 Sequencing: Recombinant DNA technology

5

1 **Start card** Sections of DNA with specific genes are identified in donor DNA

2 The desired gene is extracted from the donor DNA using specific restriction enzymes

3 Each restriction enzyme cuts at a specific base sequence

4 The fragment of donor DNA extracted has specific sticky ends

5 A vector, such as a plasmid, is selected to transfer the donor DNA into a host cell

6 The plasmid is treated with the same restriction enzyme used on the donor DNA

7 The plasmid is cut open to produce complementary sticky ends to the donor DNA fragment

8 The donor DNA is joined to the plasmid due to complementary base pairing

9 A marker gene, e.g. for antibiotic resistance, may also be joined to the plasmid along with the donor gene

10 DNA ligase is used to join the sugar-phosphate backbones of the DNA pieces together

11 The plasmid is added to host cells and heat shock treatment aids uptake of the plasmid by host cells

12 Cells are grown on antibiotic to select the transformed cells (cells containing the plasmid)

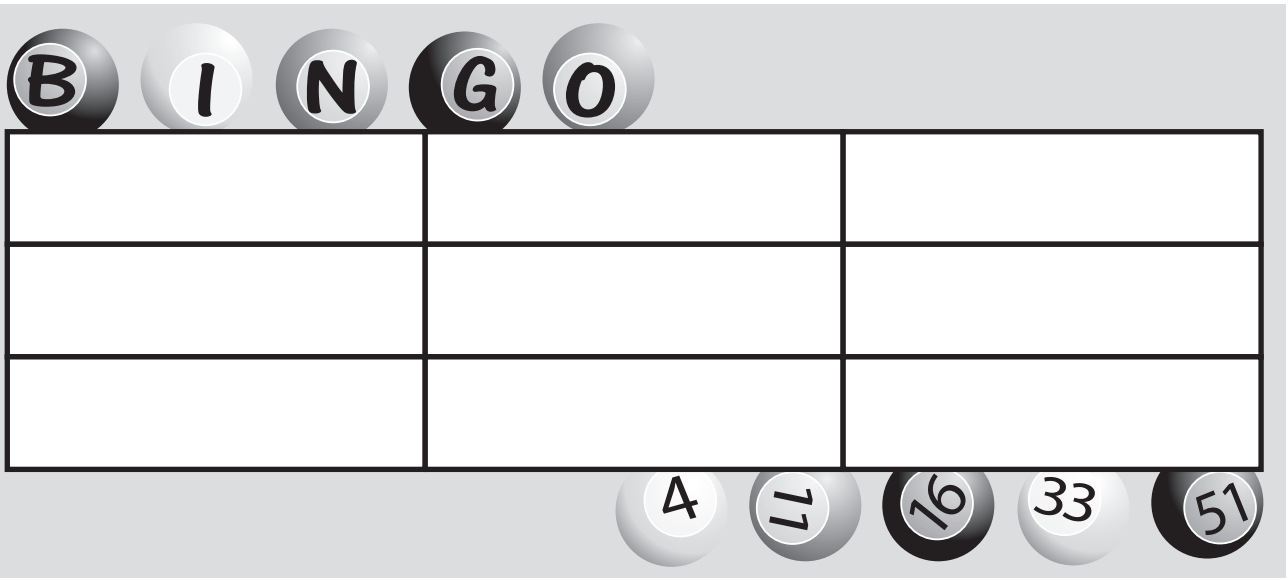
6 Ecology

- A2 Bingo: Ecology
- A2 Dominoes: Ecology
- A2 Jigsaw: Carbon and nitrogen cycles
- A2 Matching: Ecological terms

A2 Bingo: Ecology

6

Intraspecific competition
Interspecific competition
Niche
Habitat
Population
Community
Trophic level
Ecosystem
Hypothesis
Random sampling
Mark-release-recapture
Quadrat
Transect
Pitfall trap
Kick sample
Pooter



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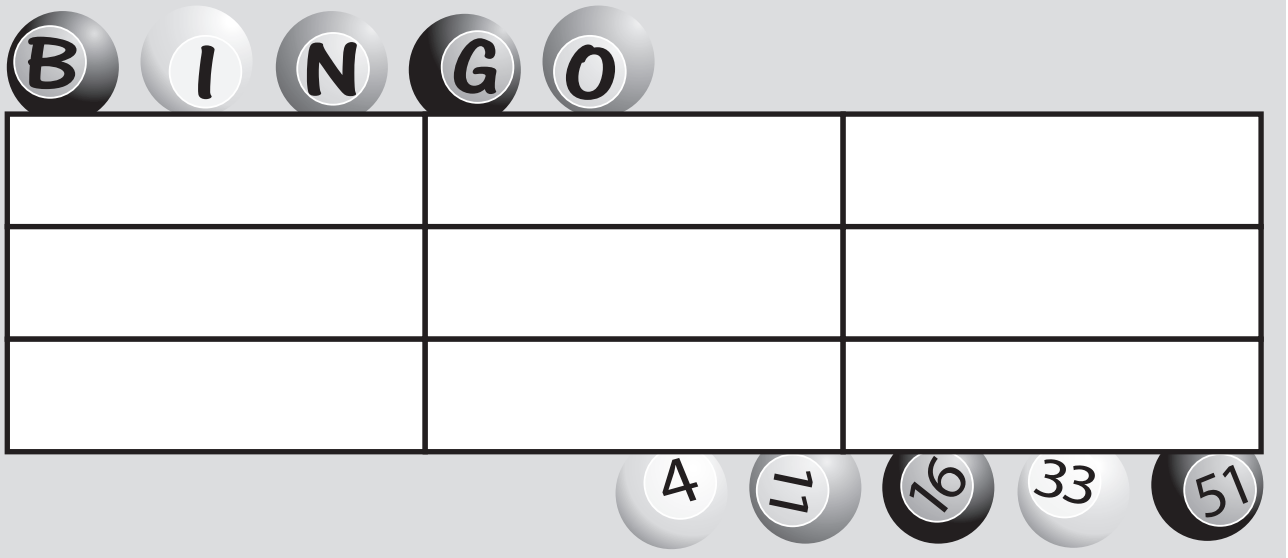


Teacher definitions

Community
All the populations that live in a particular place at the same time

Ecosystem
The community of living organisms and the biotic factors that affect them

Habitat
The place within an ecosystem where a population lives

Hypothesis
A testable idea to explain an observable event

Interspecific competition
Individuals of more than one species attempt to make use of the same scarce resources

Intraspecifc competition
Individuals of the same species attempt to make use of the same scarce resources

Kick sample
A method of collecting small invertebrates in water

Mark-release-recapture
A method of estimating the population size of motile organisms

Niche
The role an organism has in an ecosystem, including where it lives and what it eats

Pitfall trap
A method of collecting small, motile organisms on land

Pooter
Apparatus for collecting individual, small organisms

Population
All the organisms of the same species living together in a particular habitat

Quadrat
A basic tool for ecological sampling

Random sampling
A method ensuring no bias in the data

Transect
A method used to investigate trends in an area

Trophic level
The position an organism occupies in a food chain

A2 Dominoes: Ecology

Q	A
How energy passes along ecosystems	Sunlight
All the organisms of one species in a given area	Pyramid of number
Units for pyramids of energy	Producer
Simplest type of pyramid to produce	Respiration
How food chains are linked in an ecosystem	Trophic level
Approximate percentage of energy wasted between trophic levels	Primary consumer

A2 Dominoes: Ecology

A	Q
Niche	A community of living organisms and the abiotic factors affecting them
Ecosystem	How energy enters an ecosystem
Net productivity	Type of pyramid that is always the correct shape
Decomposers	Ways in which energy is lost between trophic levels
Pyramid of energy	How all energy in food chains is eventually dissipated
Food chain	The position an organism occupies in a food chain

A2 Dominoes: Ecology

A	Q
$kg\ m^{-2}$	Energy available to the next trophic level
Reflected; misses chlorophyll	Term referring to energy fixed in photosynthesis
Photosynthesis	The source of all energy in an ecosytem
Food web	Approximate percentage of energy available to the next trophic level
Community	The role of an organism in its environment
10%	Organism at the start of a food chain

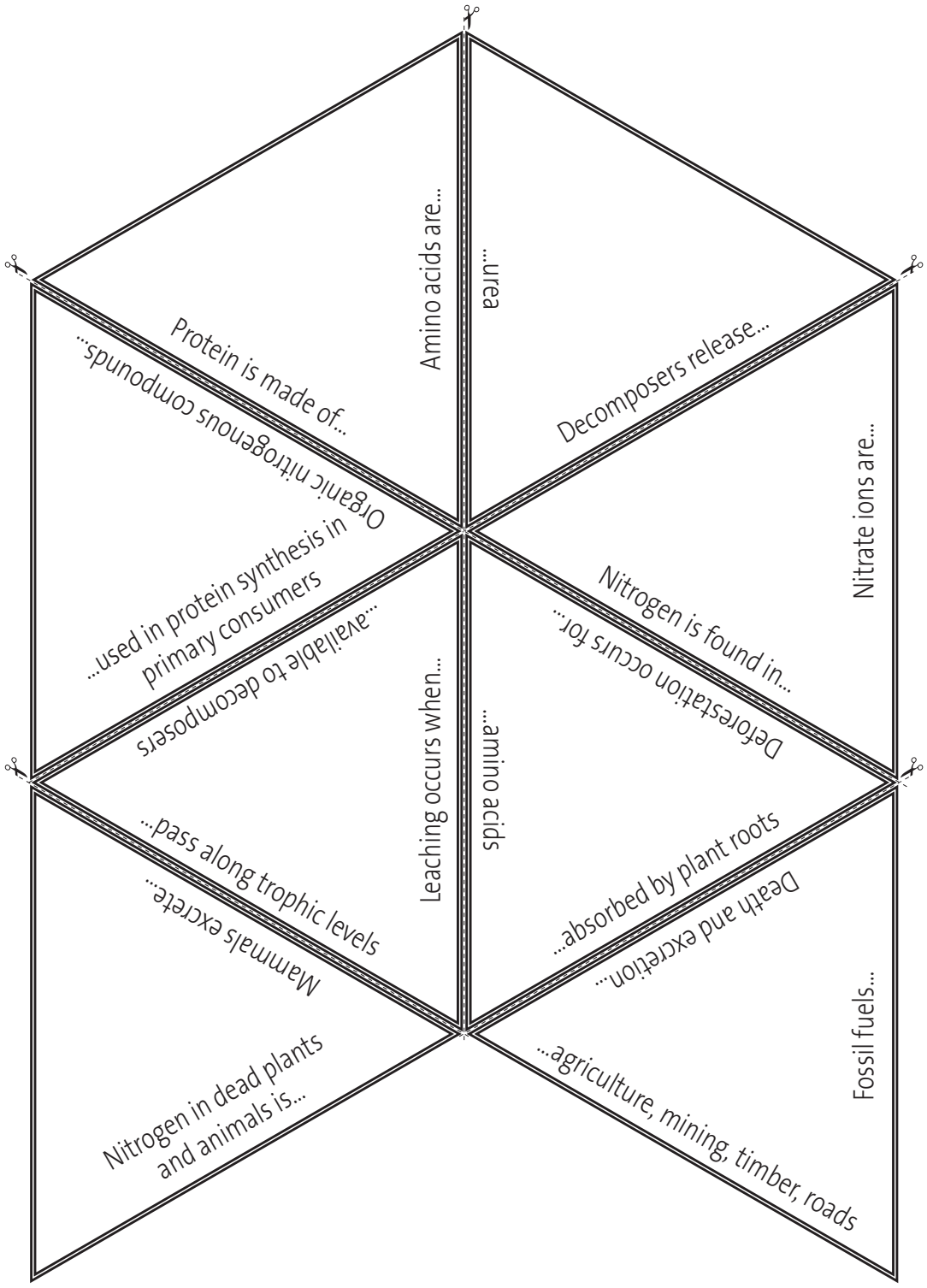
A2 Dominoes: Ecology

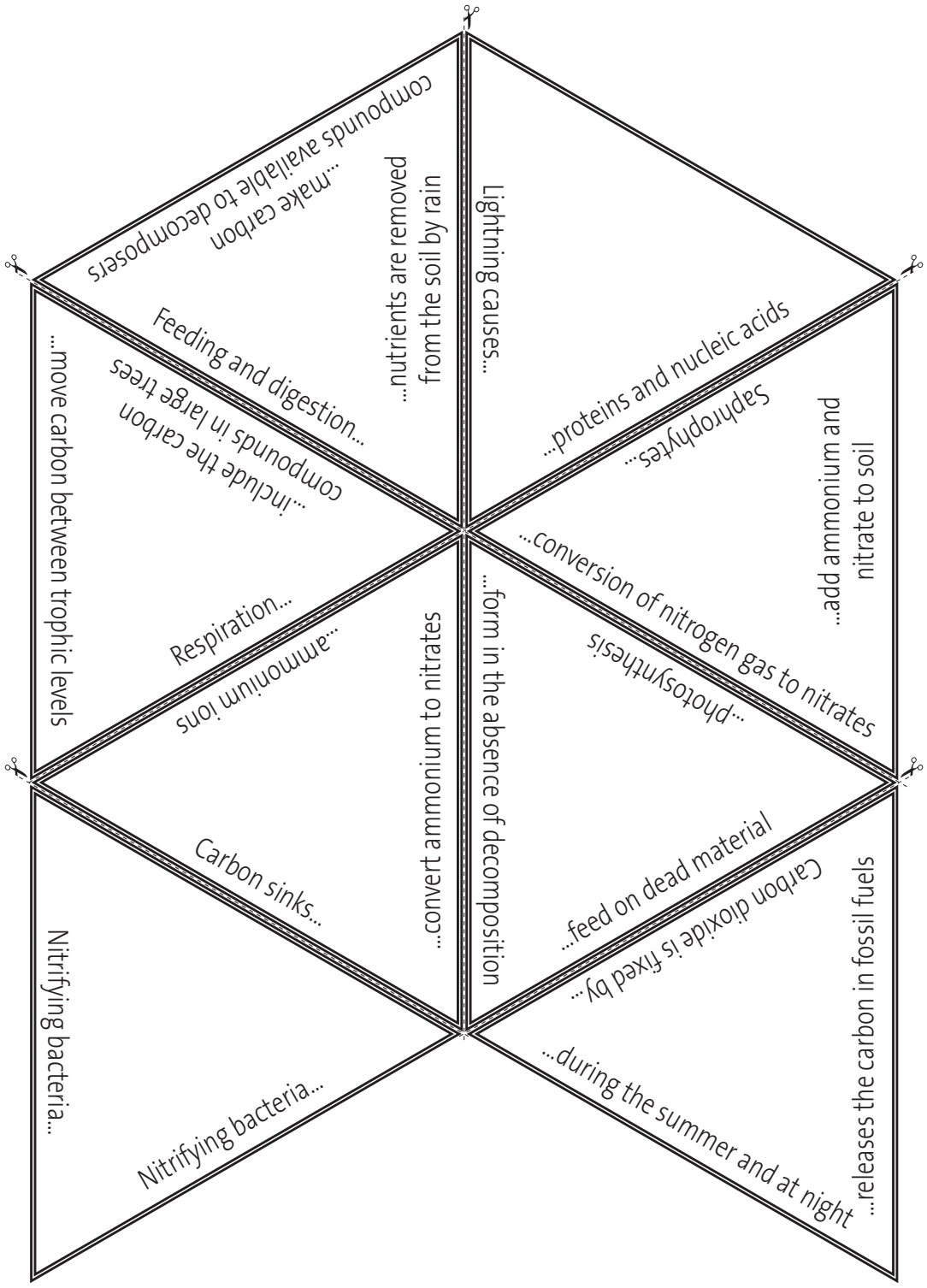
A	Q
90%	Organisms that break down dead material
Population	Two reasons why not all sunlight is used for photosynthesis
Excretion, respiration	Units for pyramid of biomass
kJ m^{-2} yr^{-1}	Animal that feeds directly on producers
Gross production	All the living organisms in an ecosystem, interconnected by food webs
Heat	Gross production – Net production =

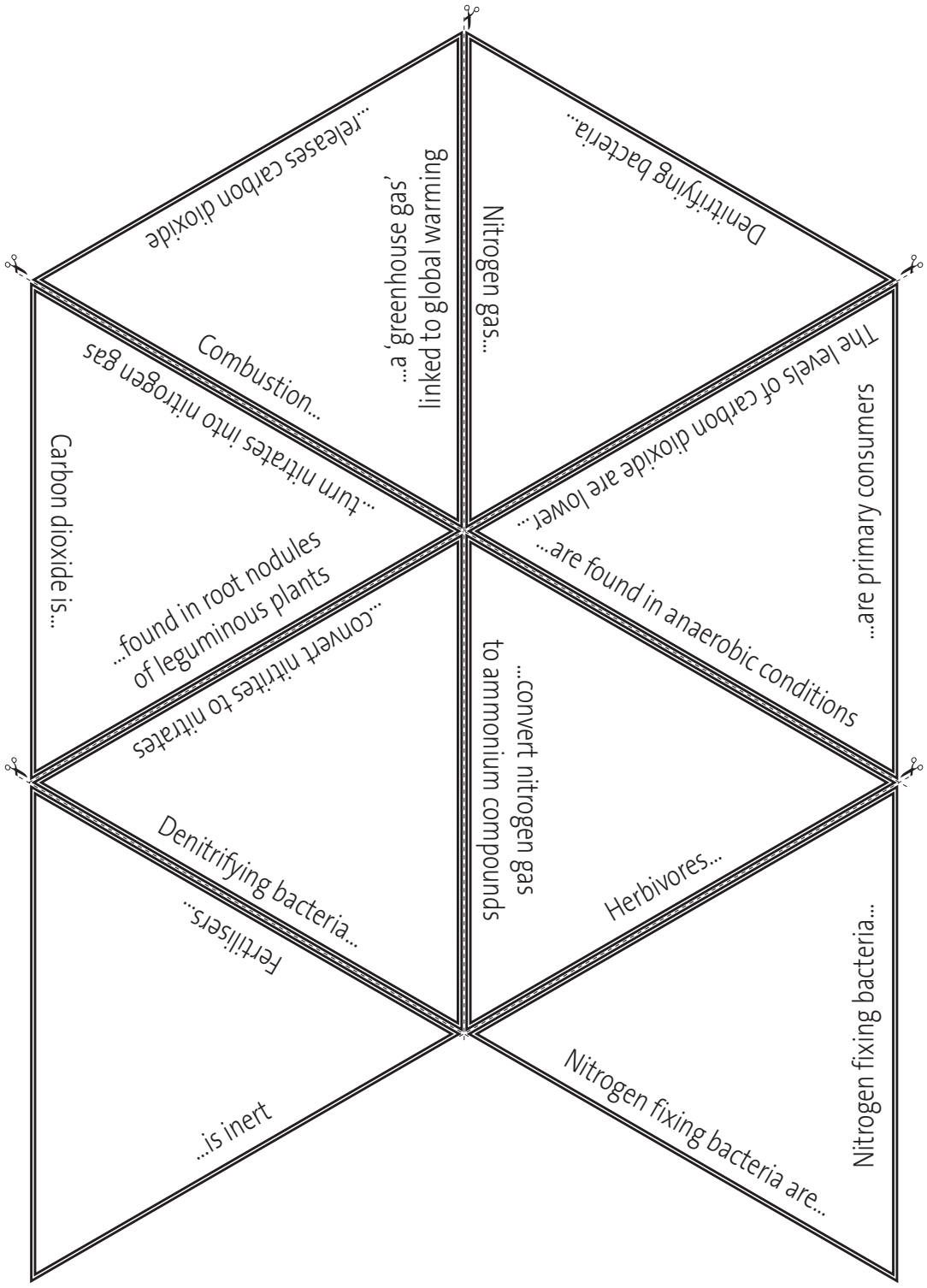
Teacher answers

A	Q
Ecosystem	How energy enters an ecosystem
Photosynthesis	The source of all energy in an ecosytem
Sunlight	How energy passes along ecosystems
Food chain	The position an organism occupies in a food chain
Trophic level	How food chains are linked in an ecosystem
Food web	Approximate percentage of energy available to the next trophic level
10%	Organism at the start of a food chain
Producer	Units for pyramids of energy
kJ m^{-2} yr^{-1}	Animal that feeds directly on producers
Primary consumer	Approximate percentage of energy wasted between trophic levels
90%	Organisms that break down dead material
Decomposers	Ways in which energy is lost between trophic levels
Excretion, respiration	Units for pyramid of biomass
kg m^{-2}	Energy available to the next trophic level
Net productivity	Type of pyramid that is always the correct shape
Pyramid of energy	How all energy in food chains is eventually dissipated
Heat	Gross production – Net production =
Respiration	Simplest type of pyramid to produce
Pyramid of number	All the organisms of one species in a given area
Population	Two reasons why not all sunlight is used for photosynthesis
Reflected; misses chlorophyll	Term referring to energy fixed in photosynthesis
Gross production	All the living organisms in an ecosystem, interconnected by food webs
Community	The role of an organism in its environment
Niche	A community of living organisms and the abiotic factors affecting them

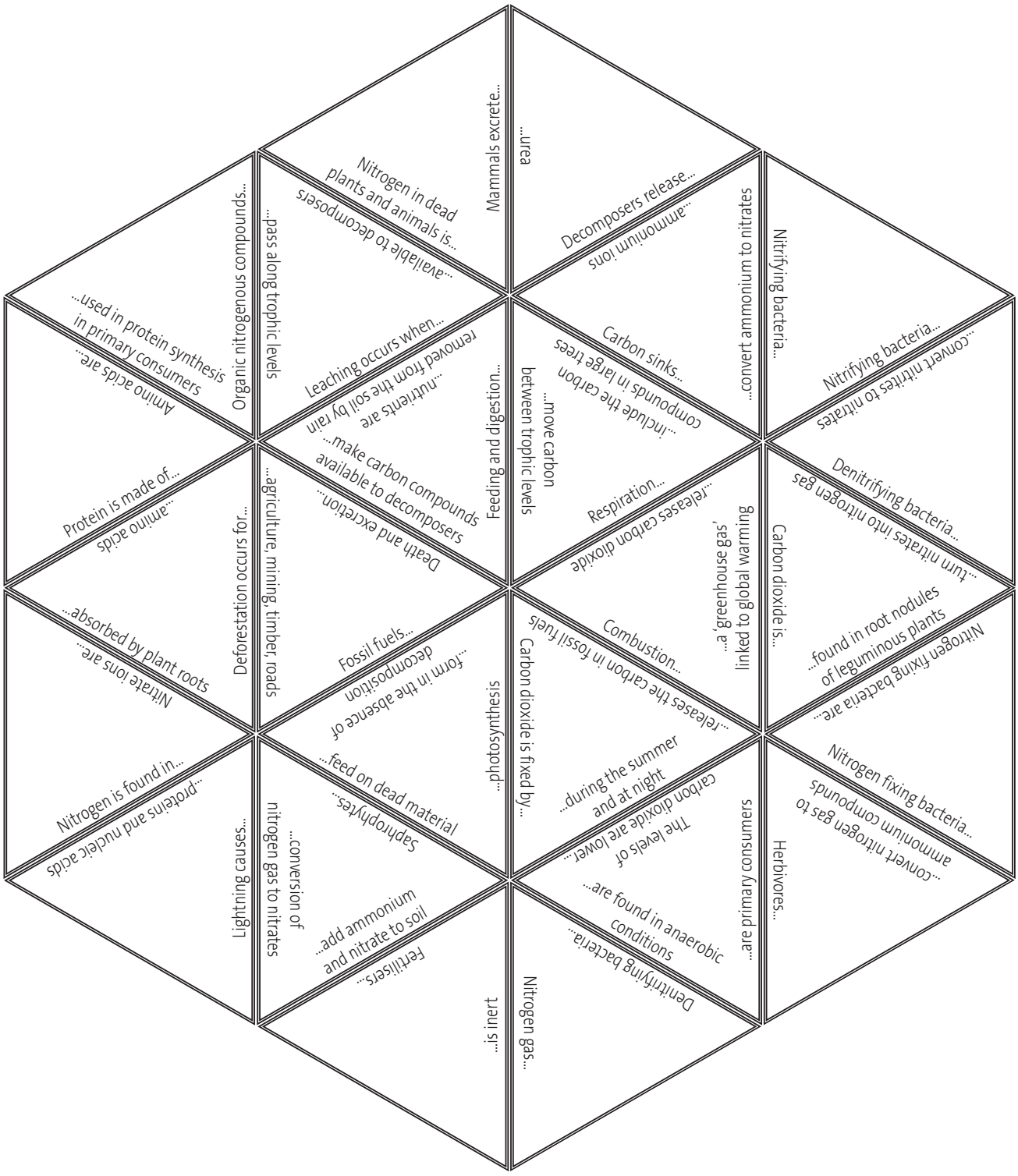
A2 Jigsaw: Carbon and nitrogen cycles







Teacher answers



A2 Matching: Ecological terms

6

Respiration	Ecosystem	Interspecific competition
Sere	Population	Succession
Climax community	Community	Autotroph

Food web	Biomass	Pioneer
Biotic factors	Trophic level	Habitat
Niche	Food chain	Intraspecific competition

Gross productivity	Net productivity	Consumers
Producers	Heterotroph	Abiotic factors
All the populations that live in a particular place at the same time	The total energy fixed during photosynthesis	The energy available for the next trophic level after respiration

The name given to each stage in a succession	The role an organism has in an ecosystem, including where it lives and what it eats	Biological features of the environment that have an effect on a population of organisms
Heterotrophs, which obtain nourishment by feeding on other organisms	All the organisms of the same species living together in a particular habitat	Physical and chemical features of the environment that have an effect on a population of organisms
A linked series of living organisms, each of which is the food for the next level, showing energy flow through the ecosystem	The complex interactions between food chains in an ecosystem	An organism producing its own food from simple inorganic materials, e.g. by photosynthesis

The position an organism occupies in a food chain	The changes that occur in an ecosystem over time	Green plants and some bacteria that make their own food
The place within an ecosystem where a population lives	The community of living organisms and the biotic factors that affect them	The end stage in a succession
Individuals of more than one species attempt to make use of the same scarce resources	A plant species found in the early stage of succession	The process whereby cells release energy from organic molecules

A2 Matching: Ecological terms

The dry mass of organisms	An organism obtaining food by feeding on complex organic matter, i.e. a consumer	Individuals of the same species attempt to make use of the same scarce resources

A2 Matching: Ecological terms

Teacher answers

Abiotic factors	Physical and chemical features of the environment that have an effect on a population of organisms
Biotic factors	Biological features of the environment that have an effect on a population of organisms
Ecosystem	The community of living organisms and the biotic factors that affect them
Producers	Green plants and some bacteria that make their own food
Consumers	Heterotrophs, which obtain nourishment by feeding on other organisms
Trophic level	The position an organism occupies in a food chain
Community	All the populations that live in a particular place at the same time
Population	All the organisms of the same species living together in a particular habitat
Habitat	The place within an ecosystem where a population lives
Niche	The role an organism has in an ecosystem, including where it lives and what it eats

A2 Matching: Ecological terms

Succession	The changes that occur in an ecosystem over time
Climax community	The end stage in a succession
Pioneer	A plant species found in the early stage of succession
Interspecific competition	Individuals of more than one species attempt to make use of the same scarce resources
Gross productivity	The total energy fixed during photosynthesis
Net productivity	The energy available for the next trophic level after respiration
Biomass	The dry mass of organisms
Food chain	A linked series of living organisms, each of which is the food for the next level, showing energy flow through the ecosystem
Food web	The complex interactions between food chains in an ecosystem
Autotroph	An organism producing its own food from simple inorganic materials, e.g. by photosynthesis

A2 Matching: Ecological terms

Heterotroph	An organism obtaining food by feeding on complex organic matter, i.e. a consumer
Respiration	The process whereby cells release energy from organic molecules
Intraspecific competition	Individuals of the same species attempt to make use of the same scarce resources
Sere	The name given to each stage in a succession

7 Photosynthesis and respiration

- A2 Bingo: Respiration and photosynthesis
- A2 Dominoes: Respiration
- A2 Sequencing: Photosynthesis
- A2 Triominoes: Photosynthesis

A2 Bingo: Respiration and photosynthesis

7

Metabolic pathway
Reduction
Oxidation
Phosphorylation
NAD
NADP
Matrix
Stroma
Thylakoids
Cristae
Link reaction
Glycolysis
Photolysis
Pyruvate
Ribulose bisphosphate
Triose phosphate
Lactate

Metabolic pathway
Reduction
Oxidation
Phosphorylation
NAD
NADP
Matrix
Stroma
Thylakoids
Cristae
Link reaction
Glycolysis
Photolysis
Pyruvate
Ribulose bisphosphate
Triose phosphate
Lactate

Teacher definitions

Cristae
Location of oxidative phosphorylation

Glycolysis
Conversion of glucose to pyruvate

Lactate
Produced in anaerobic respiration

Link reaction
Conversion of pyruvate to acetyl CoA

Matrix
Location of Krebs cycle

Metabolic pathway
Series of reactions controlled by enzymes

NAD
Coenzyme in respiration

NADP
Coenzyme in photosynthesis

Oxidation
Loss of hydrogen or electrons

Phosphorylation
Addition of phosphate

Photolysis
Splitting of water using light energy

Pyruvate
3-carbon compound

Reduction
Gain of hydrogen or electrons

Ribulose bisphosphate
5-carbon compound

Stroma
Location of light-independent reactions of photosynthesis

Thylakoids
Location of light-dependent reactions of photosynthesis

Triose phosphate
Used to form glucose

A2 Dominoes: Respiration

Q	A
Oxidative phosphorylation generates most...	...electrons
Glycolysis occurs in...	...muscle cells
Decarboxylation is...	...loss of hydrogen
Electrons are gained in...	...produces acetyl coenzyme A
The link reaction...	...the matrix
Reduced FAD...	...the cytoplasm

A2 Dominoes: Respiration

Q Anaerobic respiration in plants and yeast…

A …on the cristae

Q The Krebs cycle involves loss…

A …electron carrier proteins

Q Anaerobic respiration requires no…

A …loss of carbon dioxide

Q Aerobic respiration…

A …common pathway

Q The Krebs cycle occurs in…

A …generates 3 ATP

Q Reduced NAD…

A …ATP

A2 Dominoes: Respiration

A	Q
…substrate-level phosphorylation	Glycolysis is known as the…
…the terminal acceptor of electrons	Anaerobic respiration can occur in…
…gain of hydrogen	Oxidation is loss of…
…of the ATP	Anaerobic respiration in animal cells…
…reduction	Oxidative phosphorylation occurs…
…produces ethanol	Reduction is…

A2 Dominoes: Respiration

Q	A
Oxidative phosphorylation involves...	...produces lactate
Oxidation is...	...requires oxygen
The Krebs cycle generates ATP by...	...of carbon dioxide
Oxygen is...	...oxygen
Anaerobic respiration generates very little...	...generates 2 ATP

Teacher answers

A	Q
...generates 3 ATP	The Krebs cycle occurs in...
...the matrix	The link reaction...
...produces acetyl coenzyme A	Electrons are gained in...
...reduction	Oxidative phosphorylation occurs...
...on the cristae	Anaerobic respiration in plants and yeast...
...produces ethanol	Reduction is...
...gain of hydrogen	Oxidation is loss of...
...electrons	Oxidative phosphorylation generates most...
...of the ATP	Anaerobic respiration in animal cells...
...produces lactate	Oxidative phosphorylation involves...
...electron carrier proteins	The Krebs cycle involves loss...
...of carbon dioxide	The Krebs cycle generates ATP by...
...substrate-level phosphorylation	Glycolysis is known as the...
...common pathway	Aerobic respiration...
...requires oxygen	Oxidation is...
...loss of hydrogen	Decarboxylation is...
...loss of carbon dioxide	Anaerobic respiration requires no...
...oxygen	Oxygen is...
...the terminal acceptor of electrons	Anaerobic respiration can occur in...
...muscle cells	Glycolysis occurs in...
...the cytoplasm	Reduced FAD...
...generates 2 ATP	Anaerobic respiration generates very little...
...ATP	Reduced NAD...

A2 Sequencing: Photosynthesis

Light-dependent reactions

1	**Start card** Light energy from sunlight enters chloroplast
2	Light energy is absorbed by chlorophyll on thylakoid membranes
3	Light energy excites electrons in chlorophyll from photosystem II, which pass to electron acceptor molecules
4	Electrons from photosystem II are replaced, because light energy also causes photolysis (it splits water into hydrogen ions, electrons and oxygen)
5	Electrons from photolysis can replace those lost by chlorophyll in photosystem II
6	Electrons from photosystem II pass along a series of electron carriers, each at a lower energy level than the previous one

7 Energy released by electrons from photosystem II is used to add phosphate to ADP, forming ATP

8 Electrons from photosystem II replace those lost by chlorophyll in photosystem I

9 These excited electrons from photosystem I combine with NADP and hydrogen ions from photolysis

10 NADP becomes reduced NADP

11 Oxygen is released as a waste product

Light-independent reactions

1 **Start card** Carbon dioxide enters leaves through the stomata

2 Carbon dioxide diffuses into the stroma of the chloroplast

3 Carbon dioxide combines with a 5C compound, ribulose bisphosphate (RuBP)

4 The enzyme rubisco catalyses the reaction to form two molecules of glycerate-3-phosphate (GP)

5 GP is reduced to form triose phosphate, using hydrogen ions from reduced NADP

6 Energy from ATP is used to turn GP into triose phosphate (TP)

7 Most TP is used to regenerate RuBP by combining energy and phosphate from ATP with TP to form RuBP

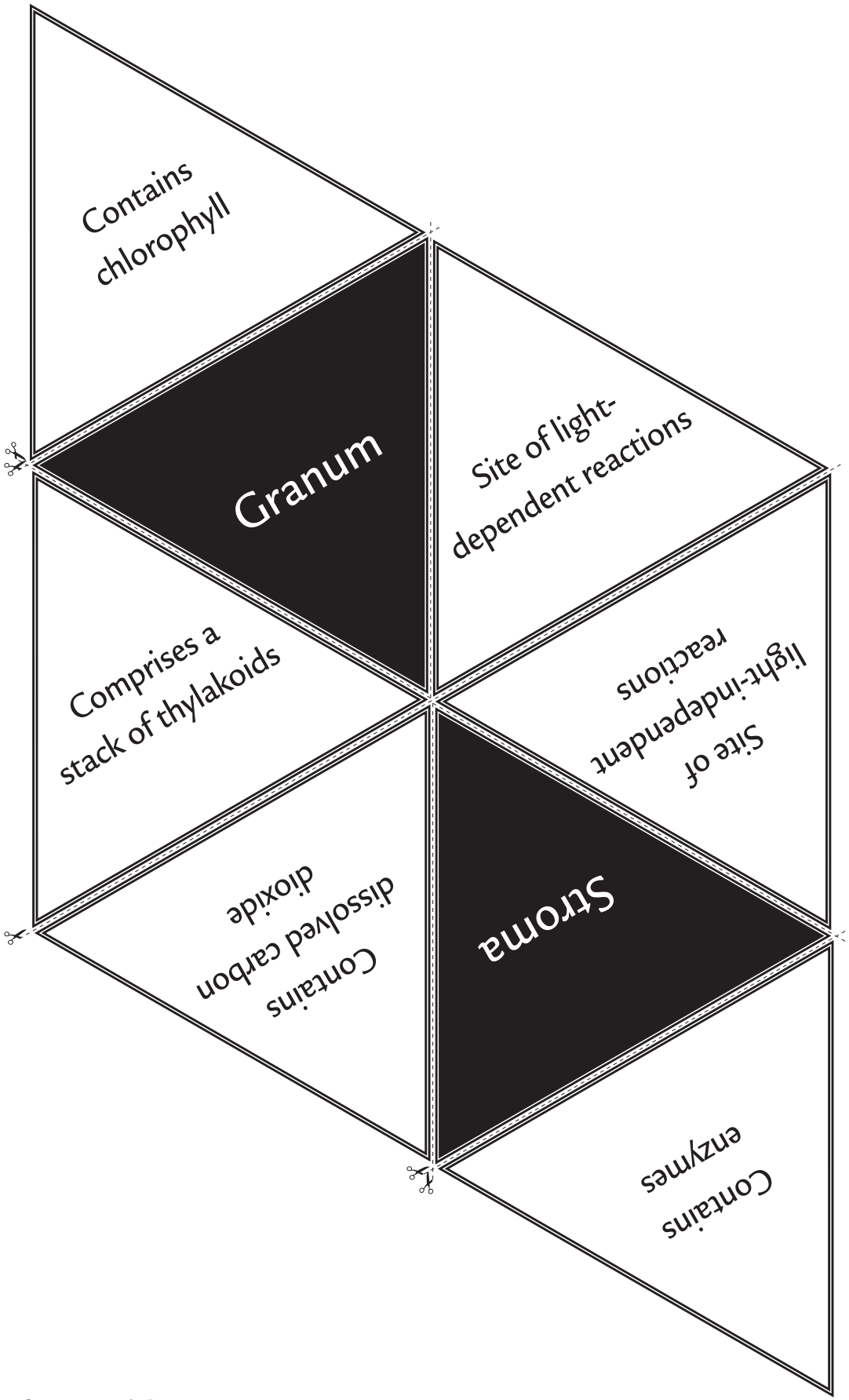
8 The cycle needs to turn six times to make enough TP to form a single glucose molecule

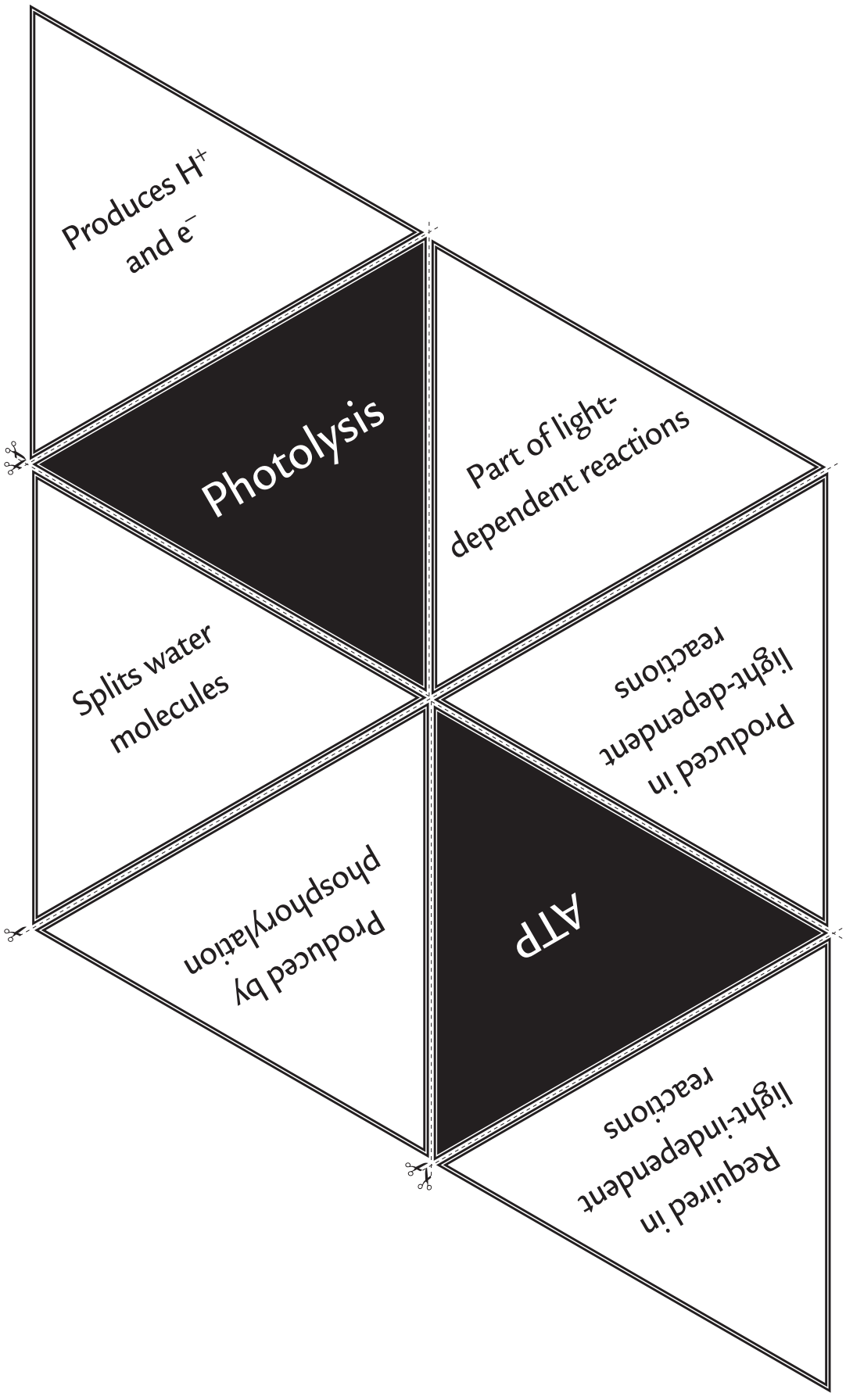
9 This means that six carbon dioxide molecules are needed to make each glucose molecule

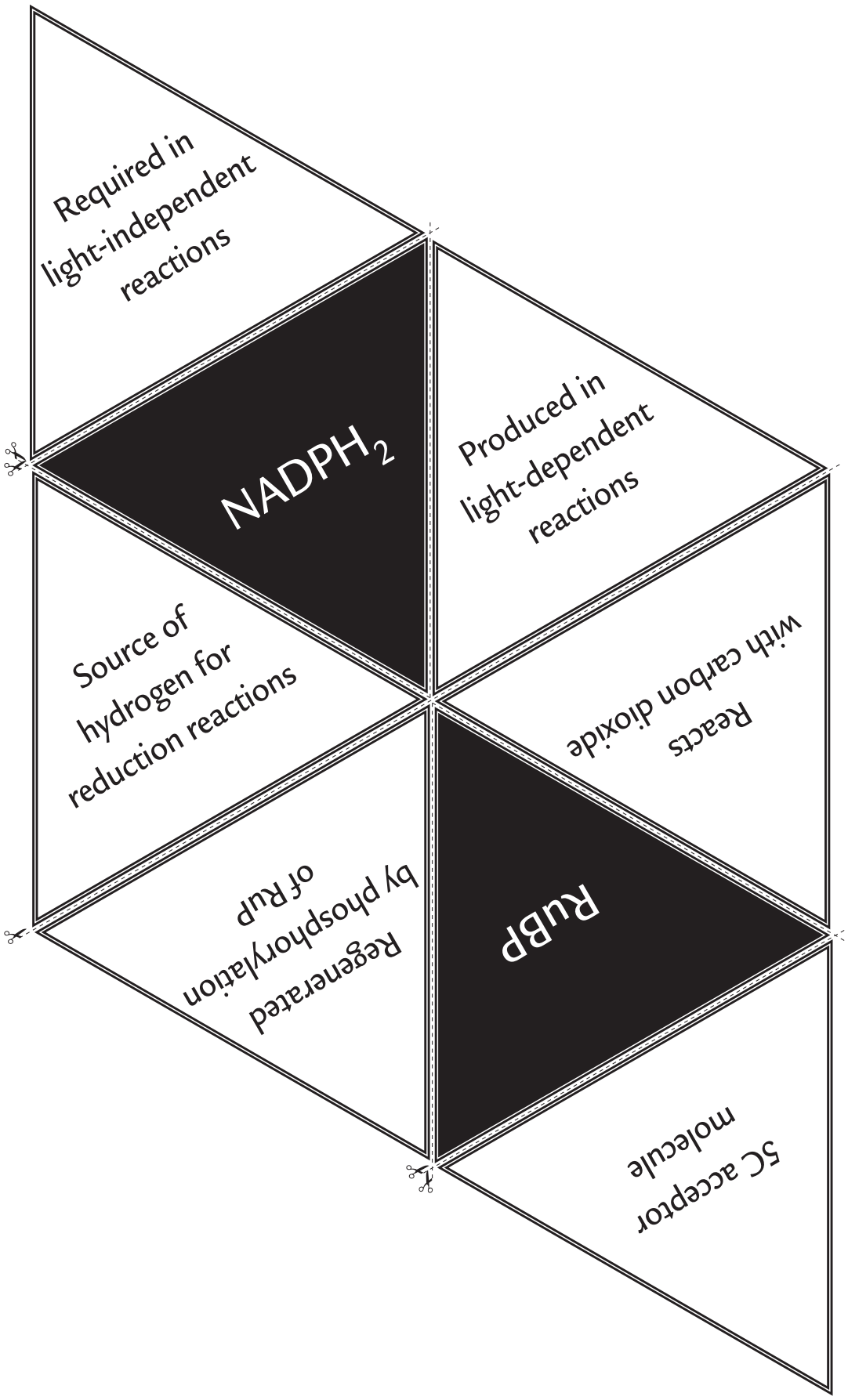
10 Other carbohydrates can be made from glucose by joining sugars in different ways

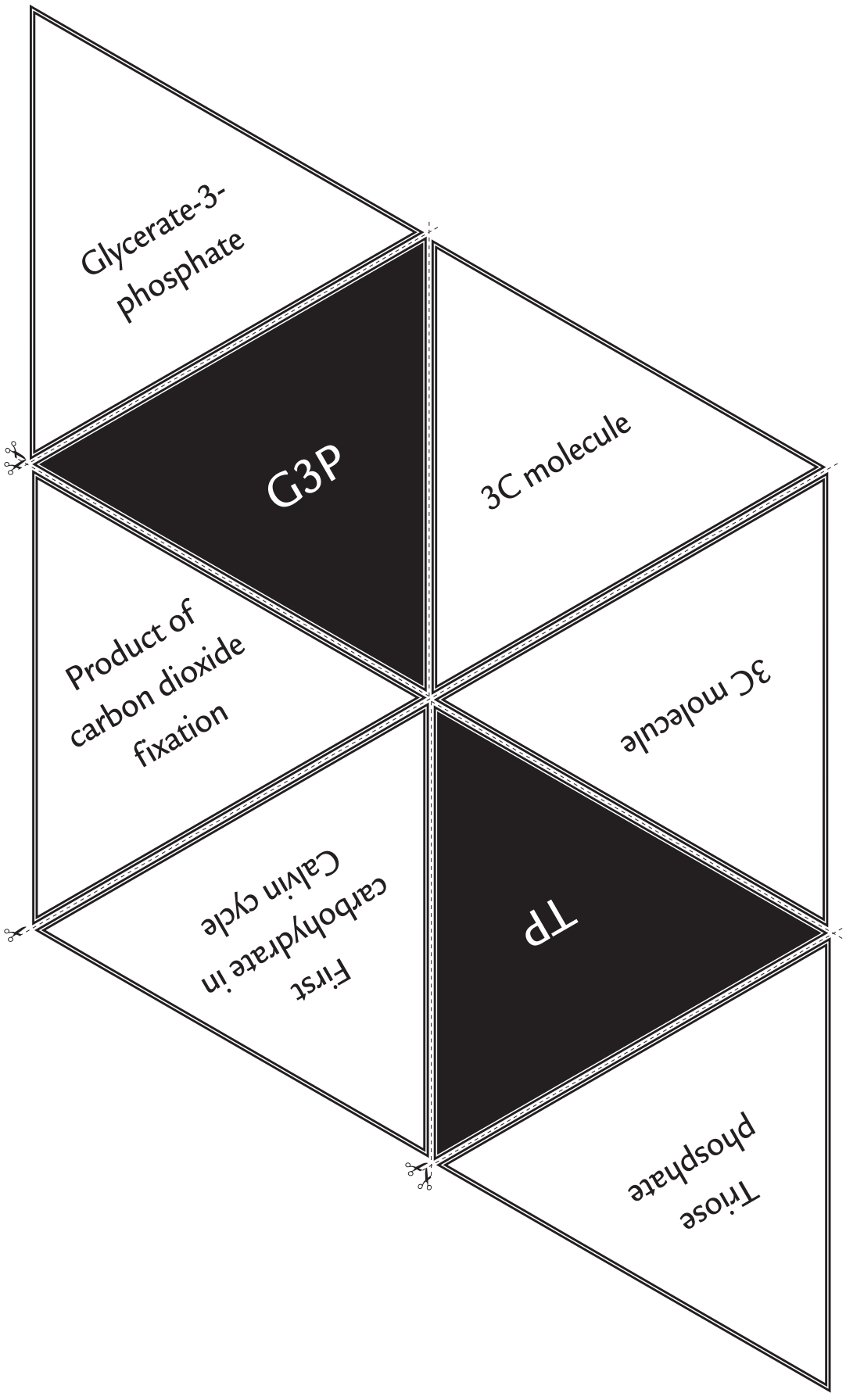
11 Lipids, amino acids and nucleic acids can also be made using TP

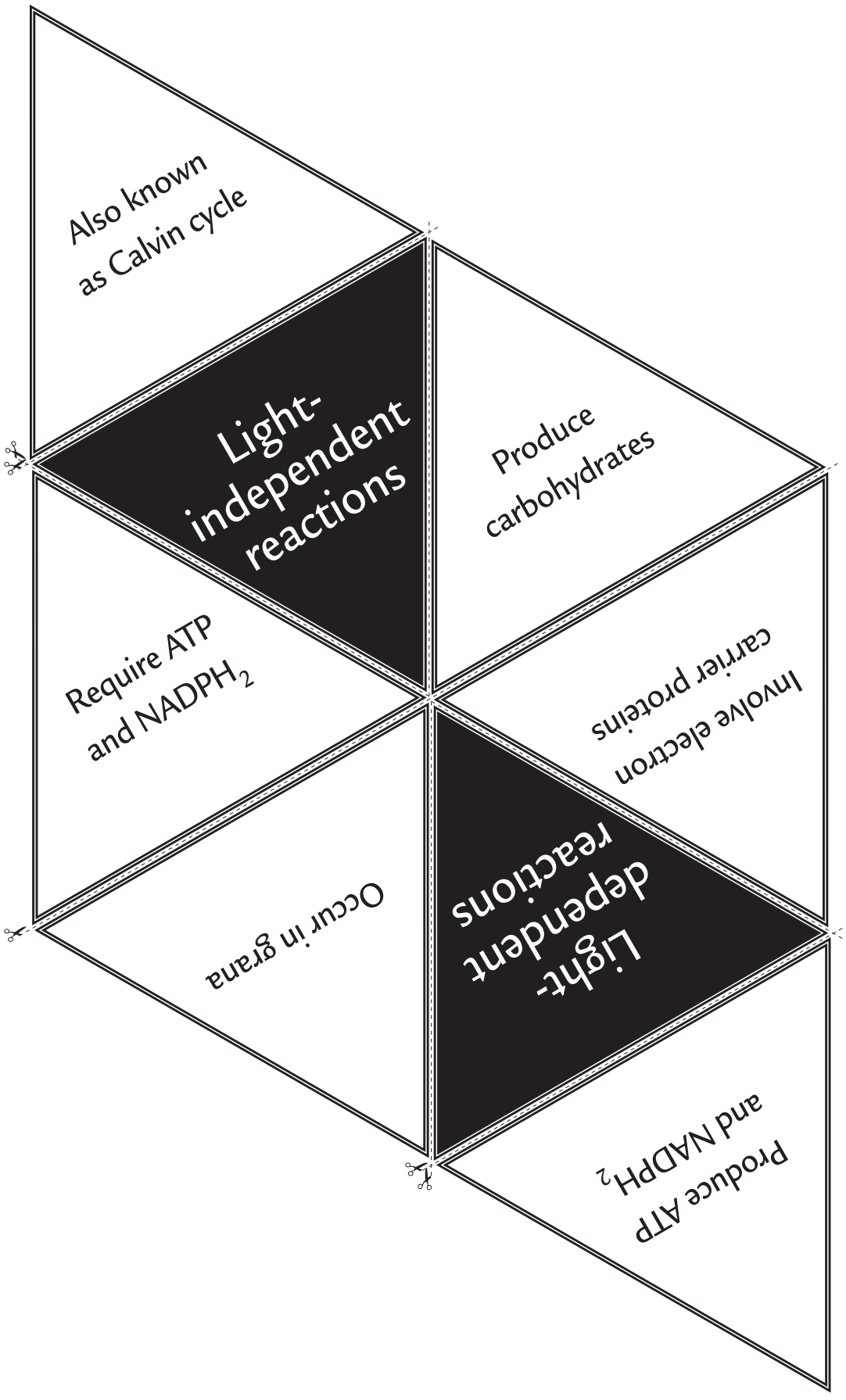
A2 Triominoes: Photosynthesis











8 Nervous and hormonal control

- A2 Dominoes: Blood glucose
- A2 Dominoes: Thermoregulation
- A2 Jigsaw: Nervous system
- A2 Sequencing: Nerve impulses and synapses

A2 Dominoes: Blood glucose

Q	A
In glycogenolysis…	…ductless gland
The endocrine gland is a…	…the islets of Langerhans
Insulin activates…	…chemicals released by the endocrine glands
Glycogen is…	…stimulates glucagon secretion
Diabetes mellitus is…	… enzymes hydrolysing glycogen
A fall in blood glucose…	…secrete glucagon

A2 Dominoes: Blood glucose

A	Q
...conversion of amino acids into glucose	A rise in blood glucose...
...uptake of glucose by liver cells	β cells...
...a storage form of carbohydrate	Glucose is...
...secretes hormones	Hormones are...
...a major respiratory substrate	A hormonal effect is...
...glucose is formed from non-carbohydrates	α cells...

A2 Dominoes: Blood glucose

A	Q
…site of hormone action	Glycogenesis is…
…maintaining a constant internal environment	In type-2 diabetes…
…glycogen is hydrolysed to glucose	In gluconeogenesis…
…turning glucose into glycogen	Type-1 diabetes is when…
… enzymes turning glucose into glycogen	Insulin increases…
…receptors on liver cells malfunction	Glucagon activates…

A2 Dominoes: Blood glucose

A ...secrete insulin

Q The endocrine region of the pancreas is found in...

A ...an inability to regulate blood glucose

Q Glucagon stimulates...

A ...slow-acting and long-lasting

Q Homeostasis means...

A ...the pancreas produces insufficient insulin

Q The endocrine gland...

A ...stimulates insulin secretion

Q Target tissue is the...

Teacher answers

A ...uptake of glucose by liver cells	Q β cells...
A ...secrete insulin	Q The endocrine region of the pancreas is found in...
A ...the islets of Langerhans	Q The endocrine gland is a...
A ...ductless gland	Q In glycogenolysis...
A ...glycogen is hydrolysed to glucose	Q In gluconeogenesis...
A ...glucose is formed from non-carbohydrates	Q α cells...
A ...secrete glucagon	Q A fall in blood glucose...
A ...stimulates glucagon secretion	Q Glycogen is...
A ...a storage form of carbohydrate	Q Glucose is...
A ...a major respiratory substrate	Q A hormonal effect is...
A ...slow-acting and long-lasting	Q Homeostasis means...
A ...maintaining a constant internal environment	Q In type-2 diabetes...
A ...receptors on liver cells malfunction	Q Glucagon activates...
A ... enzymes hydrolysing glycogen	Q Diabetes mellitus is...
A ...an inability to regulate blood glucose	Q Glucagon stimulates...
A ...conversion of amino acids into glucose	Q A rise in blood glucose...
A ...stimulates insulin secretion	Q Target tissue is the...
A ...site of hormone action	Q Glycogenesis is...
A ...turning glucose into glycogen	Q Type-1 diabetes is when...
A ...the pancreas produces insufficient insulin	Q The endocrine gland...
A ...secretes hormones	Q Hormones are...
A ...chemicals released by the endocrine glands	Q Insulin activates...
A ... enzymes turning glucose into glycogen	Q Insulin increases...

A2 Dominoes: Thermoregulation

A	Q
Hypothalamus	Which structures detect external temperature changes?
Basking, burrowing	What type of organism is an example of an ectotherm?
Ectotherm	What are heat loss mechanisms in endotherms?
Maintaining a constant internal environment	What controls the hypothalamus?
Radiation	What are heat conservation mechanisms in endotherms?
Adrenaline	What are examples of behavioural control of temperature?

A2 Dominoes: Thermoregulation

A Increases respiration, generating heat	**Q** What effect will a low body temperature have?
A Skin thermoreceptors	**Q** What are two mechanisms for heat production in endotherms?
A Changes in the environment causing a response to correct the change	**Q** What is homeostasis?
A Biochemical reactions are too slow	**Q** Which structures detect a stimulus?
A Effectors	**Q** What is negative feedback?
A An organism whose body temperature fluctuates with the environment	**Q** How can heat be lost directly from the skin?

A	Q
Increased metabolic rate and shivering	What is vasoconstriction?
Reptile	What hormone causes a long-term increase in metabolic rate?
Enzymes may become denatured	How does increased metabolic rate increase temperature?
An organism that can maintain a constant internal temperature	How does sweating cause heat loss?
Narrowing of skin arterioles	What is an ectotherm?
The autonomic nervous system	Where are the heat loss and conservation centres?

A2 Dominoes: Thermoregulation

A	Q
Vasoconstriction, hair erection	What is an endotherm?
Endotherm	Which hormone causes a rapid increase in metabolic rate?
Evaporation	Which type of organism relies mainly on behavioural methods of temperature control?
Receptors	What are glands and muscles?
Thyroxine	Why is too high a body temperature dangerous?
Sweating, vasodilation	Which type of organism has a more constant metabolic rate?

Teacher answers

A Biochemical reactions are too slow

Q Which structures detect a stimulus?

A Receptors

Q What are glands and muscles?

A Effectors

Q What is negative feedback?

A Changes in the environment causing a response to correct the change

Q What is homeostasis?

A Maintaining a constant internal environment

Q What controls the hypothalamus?

A The autonomic nervous system

Q Where are the heat loss and conservation centres?

A Hypothalamus

Q Which structures detect external temperature changes?

A Skin thermoreceptors

Q What are two mechanisms for heat production in endotherms?

A Increased metabolic rate and shivering

Q What is vasoconstriction?

A Narrowing of skin arterioles

Q What is an ectotherm?

A An organism whose body temperature fluctuates with the environment

Q How can heat be lost directly from the skin?

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Q What are heat conservation mechanisms in endotherms?

A Vasoconstriction, hair erection

Q What is an endotherm?

A An organism that can maintain a constant internal temperature

Q How does sweating cause heat loss?

A Evaporation

Q Which type of organism relies mainly on behavioural methods of temperature control?

A Ectotherm

Q What are heat loss mechanisms in endotherms?

A Sweating, vasodilation

Q Which type of organism has a more constant metabolic rate?

A Endotherm

Q Which hormone causes a rapid increase in metabolic rate?

A Adrenaline

Q What are examples of behavioural control of temperature?

A Basking, burrowing

Q What type of organism is an example of an ectotherm?

A Reptile

Q What hormone causes a long-term increase in metabolic rate?

A Thyroxine

Q Why is too high a body temperature dangerous?

A Enzymes may become denatured

Q How does increased metabolic rate increase temperature?

A Increases respiration, generating heat

Q What effect will a low body temperature have?

A2 Jigsaw: Nervous system

8

A receptor...

A motor neurone...

...detectable change in the environment

A stimulus is a...

...connect neurones within the CNS

...carry impulses from receptors to the CNS

Neurotransmitters are...

Relay neurones...

...is a gap between neurones

...detects a stimulus

A synapse...

...bundle of neurones

...carries impulses towards the cell body

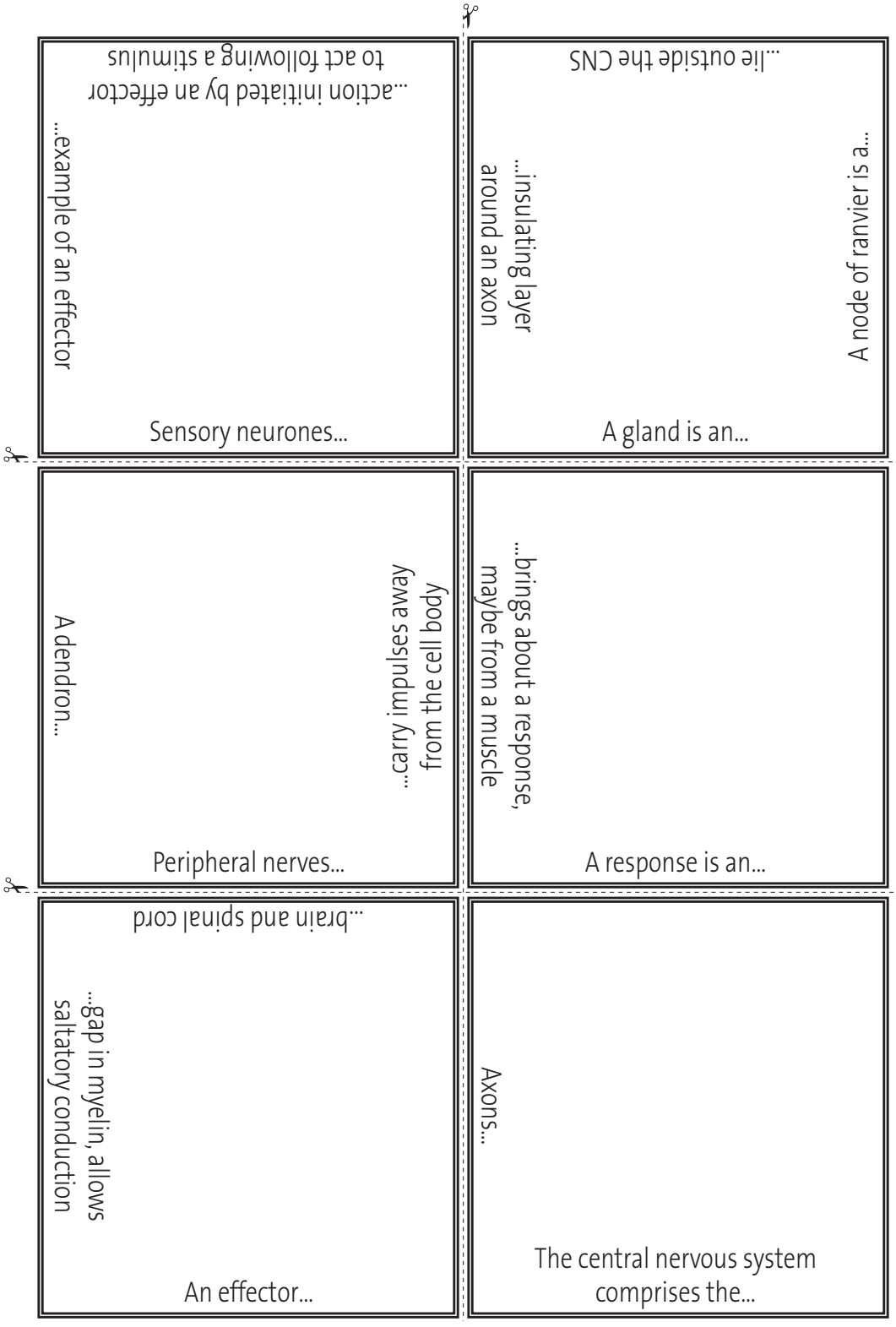
The myelin sheath is an...

...chemicals released at synapses

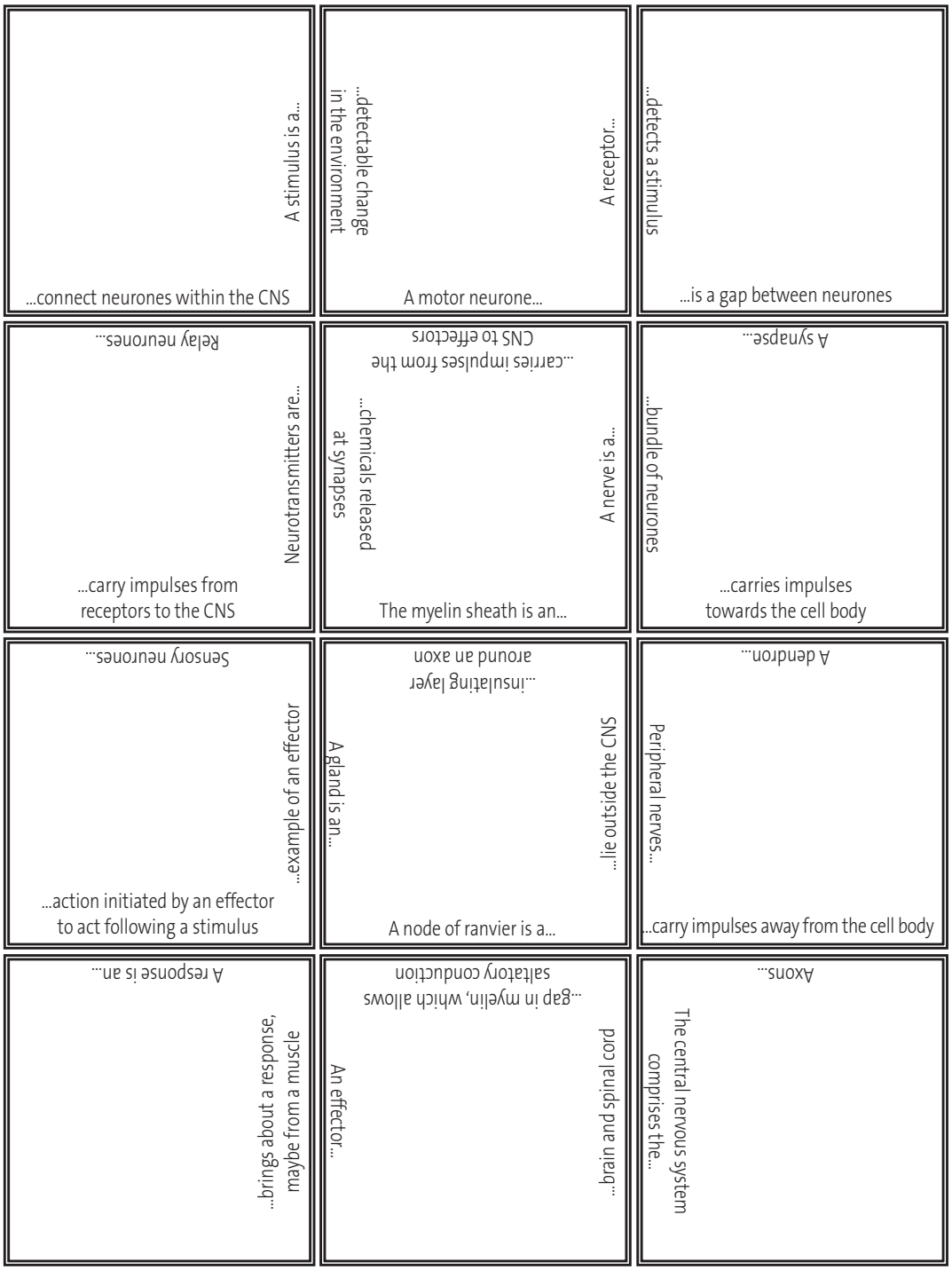
A nerve is a...

...carries impulses from the CNS to effectors

A2 Jigsaw: Nervous system



Teacher answers



A2 Sequencing: Nerve impulses and synapses

8

Resting and action potential

1 **Start card** At rest, neurones have a potential difference of about –65 mV — the resting potential

2 This is due to movement of two positive ions, potassium, K^+ and sodium, Na^+

3 A sodium-potassium pump actively transports out three sodium ions for every two potassium ions it transports in

4 Large numbers of potassium ion channels allow potassium to move out of the neurone by facilitated diffusion; sodium ions only enter slowly

5 This means that the inside of the neurone membrane is negatively charged compared with the outside

6 The membrane is polarised

7 When a neurone is stimulated at one point, large numbers of Na^+ channels open, making the membrane more permeable to these ions

8 Large numbers of Na^+ enter the cell by facilitated diffusion

9 The inside of the neurone becomes positive compared with the outside

10 The membrane is polarised

11 If the threshold is exceeded, an action potential is generated

12 The potential difference peaks at +40 mV

13 Sodium ion channels close

14 The membrane is more permeable to K^+ than to Na^+

15 Potassium ion channels now move K^+ out faster than Na^+ enter

16 The potential difference begins to fall

17 The potential difference falls below the value for resting potential

18 The membrane is hyperpolarised for a short time before returning to –65 mV

Synapse

1 **Start card** An action potential arrives at the end of the neurone

2 Calcium ion channels open in the presynaptic membrane

3 Calcium ions diffuse in

4 Calcium ions fuse with vesicles containing neurotransmitter

5 Neurotransmitter is released by exocytosis

6 Neurotransmitter enters the synaptic cleft

7 Neurotransmitter diffuses across the cleft

8 Neurotransmitter binds to receptors on the postsynaptic membrane

9 Sodium ion channels open

10 Sodium ions enter the postsynaptic neurone

11 If a threshold is exceeded, the membrane depolarises

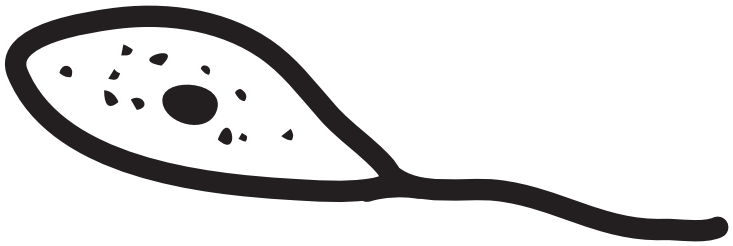
12 An action potential is generated

9 Classification

- AS Play your cards right: Classification
- AS Matching: Classification

AS Play your cards right: Classification

Prokaryotae



Protoctista

Fungi

Animalia

Plantae

Teacher questions and answers

These have no membrane-bound organelles	Prokaryotae
These all obtain nourishment by photosynthesis	Plantae
These never have a cell wall	Animalia
These may have a slime capsule	Prokaryotae
These include yeasts	Fungi
These include *E coli*	Prokaryotae
These may be multicellular or unicellular	Protoctista
These have a nervous system	Animalia
These include seaweeds	Protoctista
These have cell walls made of cellulose	Plantae
These are all saprophytic or parasitic	Fungi
These have cell walls of peptidoglycan	Prokaryotae
These may form hyphae	Fungi
These include mosses	Plantae
These have cell walls made of chitin	Fungi
These include liverworts	Plantae
These include sea anemones	Animalia
These include blue-green algae	Prokaryotae
These include *Euglena*	Protoctista
These include coral	Animalia

AS Matching: Classification

9

Species	Binomial nomenclature	Four
Phylum	Prokaryotae	Five
Hierarchy	homo sapiens	Phylogeny

Genus	One	Classification
Class	*Homo sapiens*	Kingdom
Animalia	Taxonomy	Plantae

The correct way to write the binomial name of humans	A group of similar organisms that can interbreed to produce fertile offspring	The system of giving each species a generic and a specific name
The number of eukaryotic kingdoms	The study of the evolutionary history of organisms	A taxonomic group between phylum and order
The number of kingdoms in the current classification system	One of five kingdoms in which all organisms never have cell walls and can move in at least one stage in their life cycle	The kingdom in which all organisms have no membrane-bound nucleus

A taxonomic group between family and species	The kingdom in which all organisms have cellulose walls	The number of prokaryotic kingdoms
The study of biological classification	A taxonomic group between kingdom and class	The incorrect way to write the binomial name of humans
The largest taxon in the classification system	Sorting living organisms into groups	A system in which large groups are split into smaller and smaller ones

Teacher answers

Phylogeny	The study of the evolutionary history of organisms
Five	The number of kingdoms in the current classification system
Taxonomy	The study of biological classification
Kingdom	The largest taxon in the classification system
homo sapiens	The incorrect way to write the binomial name of humans
Species	A group of similar organisms that can interbreed to produce fertile offspring
Hierarchy	A system in which large groups are split into smaller and smaller ones
Class	A taxonomic group between phylum and order
Animalia	One of five kingdoms in which all organisms never have cell walls and can move in at least one stage in their life cycle
Binomial nomenclature	The system of giving each species a generic and a specific name

AS Matching: Classification

Four	The number of eukaryotic kingdoms
Phylum	A taxonomic group between kingdom and class
Genus	A taxonomic group between family and species
Classification	Sorting living organisms into groups
Prokaryotae	The kingdom in which all organisms have no membrane-bound nucleus
One	The number of prokaryotic kingdoms
Plantae	The kingdom in which all organisms have cellulose walls
Homo sapiens	The correct way to write the binomial name of humans