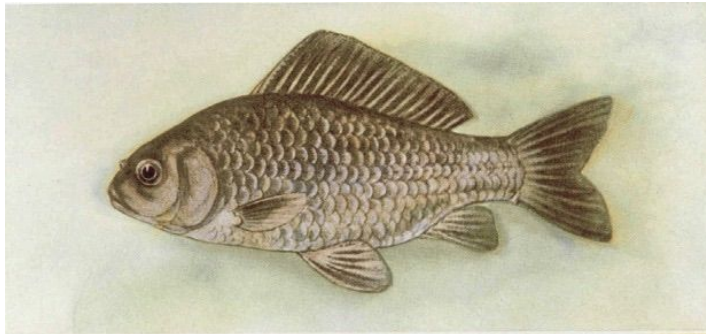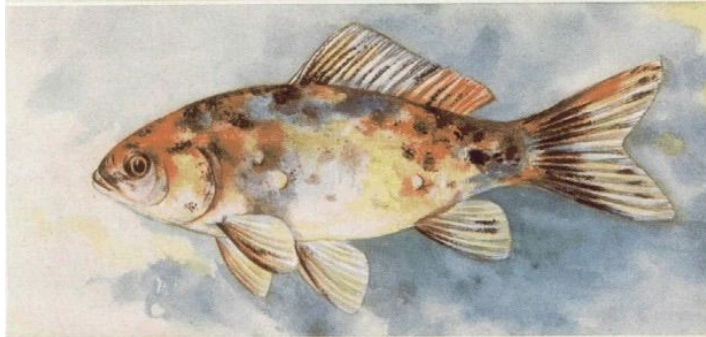# Summative Assessment Key

A. Brown Goldfish

B.   Speckled
          Goldfish

C.   Transparent
          Goldfish

Goldfish are an important symbol in Chinese culture. The Chinese have been breeding goldfish for over 2,000 years. Research on breeding and goldfish genetics began over 100 years ago. Shisan C. Chen (1894–1957) was a Chinese geneticist who made some of the first discoveries of patterns in goldfish genetics.

He wrote a paper in 1928 titled "Transparency and Mottling, a Case of Mendelian Inheritance in the Goldfish Carassius Auratus" that described his experiments and results. In his experiments, he had three different-looking goldfish (see drawings above), which he figured out were a result of whether their scales were transparent or reflective. In brown goldfish (A) the scales are reflective (you cannot see through them). Speckled goldfish (B) have some reflective and some transparent scales, and transparent goldfish (C) have all transparent scales.

Dr. Chen found that the way goldfish scales look is passed from parents to offspring in predictable patterns. Here is a summary of the main results from Dr. Chen's paper:

Brown goldfish. I made matings between females and males of the brown goldfish. The offspring of these matings consisted of only brown goldfish (top fish in drawing).
Transparent fish. I made nine matings between female and male transparent fish. These nine matings produced many thousands of offspring, all of them were transparent fish (bottom fish in drawing).
Breeding transparent fish with brown fish. I made ten matings between transparent females and brown males and ten matings between brown females and transparent males. All of these matings produced only fish with a speckled pattern (middle fish in drawing).

Breeding speckled fish with speckled fish. I made seven matings between female and male speckled fish. The results of these matings show that among the offspring there were always about ¼ transparent fish, ½ speckled fish, and ¼ brown fish.

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1200991/pdf/434.pdf

1a. Speckled goldfish are popular fish because of their beautiful colors. Synthesize the data using the obtaining and evaluating information checklist to make sense of and evaluate the information in the reading above.

See *Obtaining Information From Scientific Text Key* for suggested responses to this part of the task.

1b. With this information, visually represent each mating in Dr. Chen's scientific paper by creating 4 pedigrees, one of each mating he did in his experiment. Make four offspring for each mating, two females and two males. Be sure to include a key for phenotype and genotype in your pedigree.

Example response:
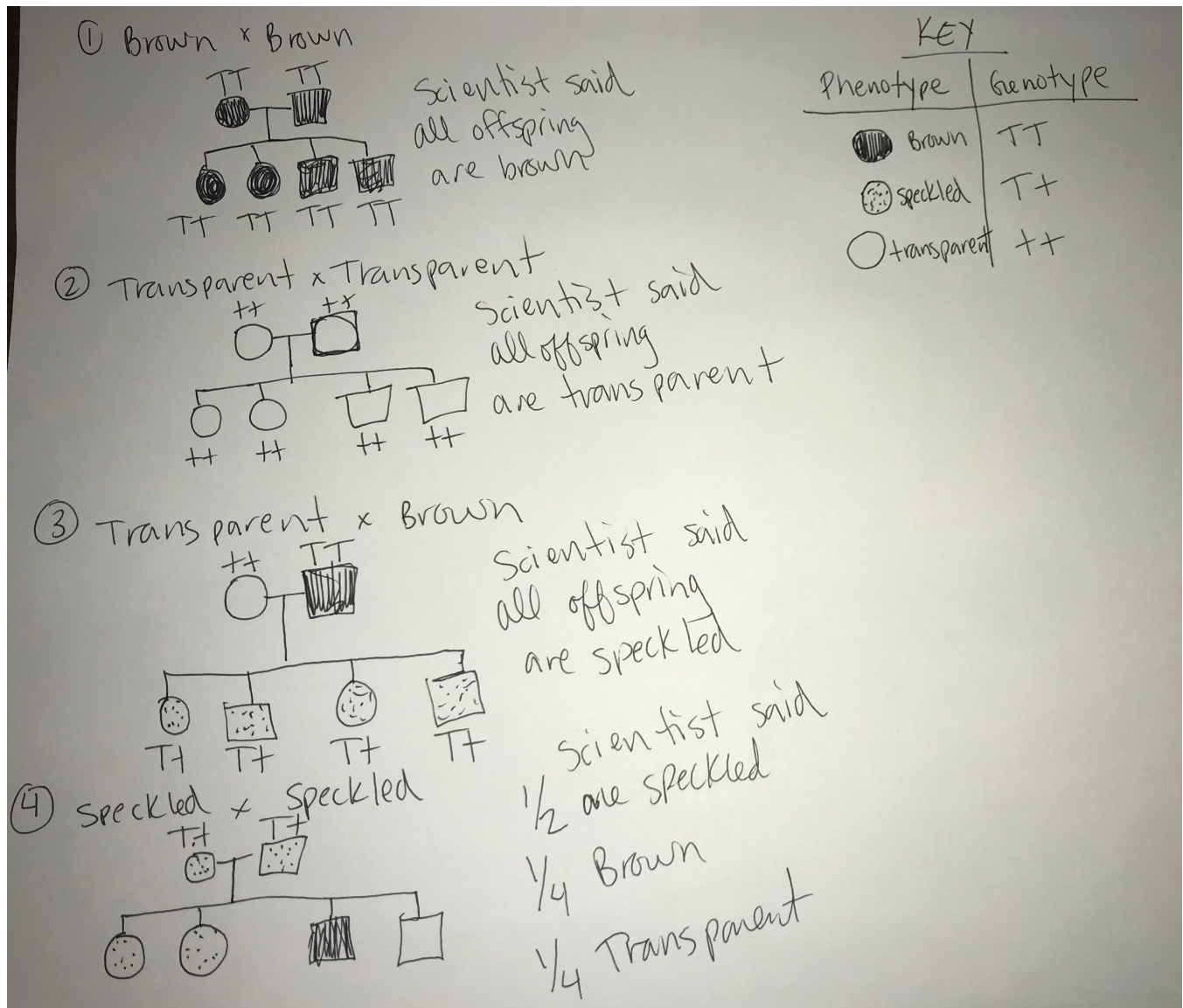
+ Student links information from the article/reading to each pedigree representation.
+ Pedigrees represent correct proportion of offspring as described in the article and shown in the example student response.
+ There is a key or some way to link genotype to phenotype in each pedigree.

1c. In 1928, when Dr. Chen did research on goldfish, scientists did not yet know about genetic information, proteins, and phenotypes. Write or draw an image that explains the connection between a transparent fish's genotype and phenotype. Include an example of the brown fish for comparison.

Example response:

Transparent Fish

Genotype:
2 Star Alleles
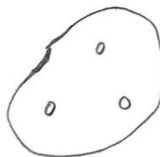
Protein:
Different Shaped protein
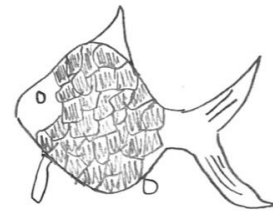
Phenotype:
◦ see through scales
◦ looks pink

Brown Fish

Genotype:
2 Triangle Alleles

Protein:
Typical Shaped protein

Phenotype:
◦ reflective scales
◦ can't see through scales
◦ looks brown

+ Student shows or describes genotypes (both homozygous with 2 of the same allele).
+ Student shows or describes the genotypes leading to proteins.
+ Protein for brown fish is typical; protein for transparent fish is a different-shaped protein.
+ Student connects protein to phenotype and describes the phenotype for each fish.

2a. If a goldfish breeder wanted to **breed speckled fish**, should the breeder mate a speckled female with a speckled male *or* a brown female with a transparent male? Which breeding combination would you recommend and why? Use a Punnett square or Probability Rules to explain your answer.

+ The breeder should breed a brown female with a transparent male because that combination will result in 100% speckled fish.
+ Breeding a speckled male with a speckled female will result only in 50% speckled fish.
+ Punnett squares or Probability Rules use representations or numbers to show alleles in the parents and offspring.

Example response:

Key BB Brown
Bb Speckled
bb Transparent

Speckled ♀ × Speckled ♂
   Bb × Bb

Eggs Ⓑ and Ⓑ   Sperm Ⓑ and Ⓑ

	Ⓑ	Ⓑ
Ⓑ	BB	Bb
Ⓑ	bB	bb

$\frac{1}{4}$ BB = 25% Brown

$\frac{1}{4}$ Bb + $\frac{1}{4}$ bB = 50% Speckled

$\frac{1}{4}$ bb = 25% Transparent

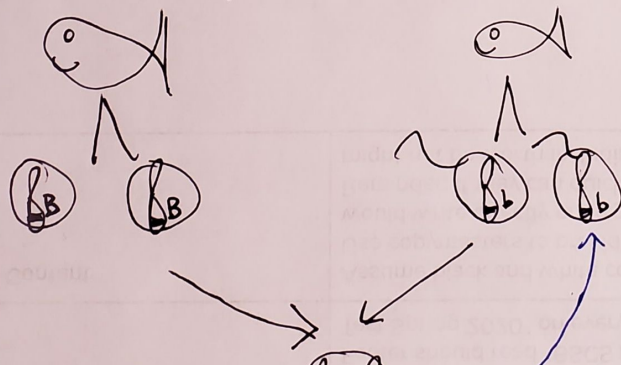Brown ♀ × Transparent ♂
   BB × bb

Eggs Ⓑ + Ⓑ   Sperm Ⓑ + Ⓑ

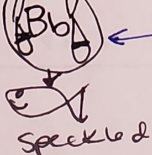|	Ⓑ	Ⓑ
Ⓑ	Bb	Bb
Ⓑ	Bb	Bb

$\frac{4}{4}$ Bb = 100% Speckled

2a) I would recommend mating the Brown female and the transparent male because 100% of the babies will be speckled. Only 50% of the babies will be speckled if you mate the speckled female to the speckled male

2b) Brown ♀ BB   Transparent ♂ bb

more likely will see
Ⓑ Ⓑ or
maybe bb bb

Speckled

This might be a stretch... not sure they will draw the chromosomes inside the cells... they have seen chromosomes w/ alleles + alleles in egg + sperm but not single chrom w/ allele in sex cell

2b. Show on your Punnett square or your math work how the representation shows the passing down of chromosomes from parents to offspring.

See example image above for additions on the Punnett squares.

+Image shows one chromosome being inherited from each parent.
+Image shows that each allele is associated with a chromosome from each parent.

3. Goldfish growth depends on many environmental factors including clean, warm water, oxygen in the water, food, and space. Scientists found only a few genes that might account for some differences in how big a goldfish can grow. In excellent environmental conditions, any goldfish can grow to be very large.

Develop a model that shows the relative influence of genetics and the environment on the range of sizes that a goldfish could be.

Example response:

Range of goldfish size

Phenotype: small goldfish

Phenotype: large goldfish
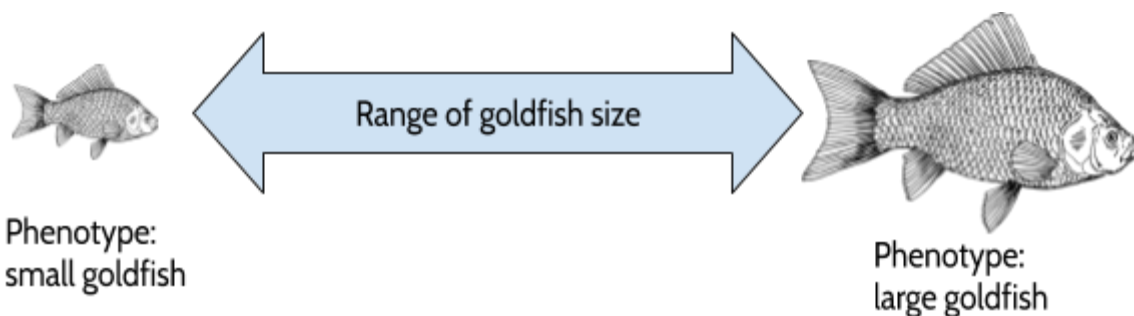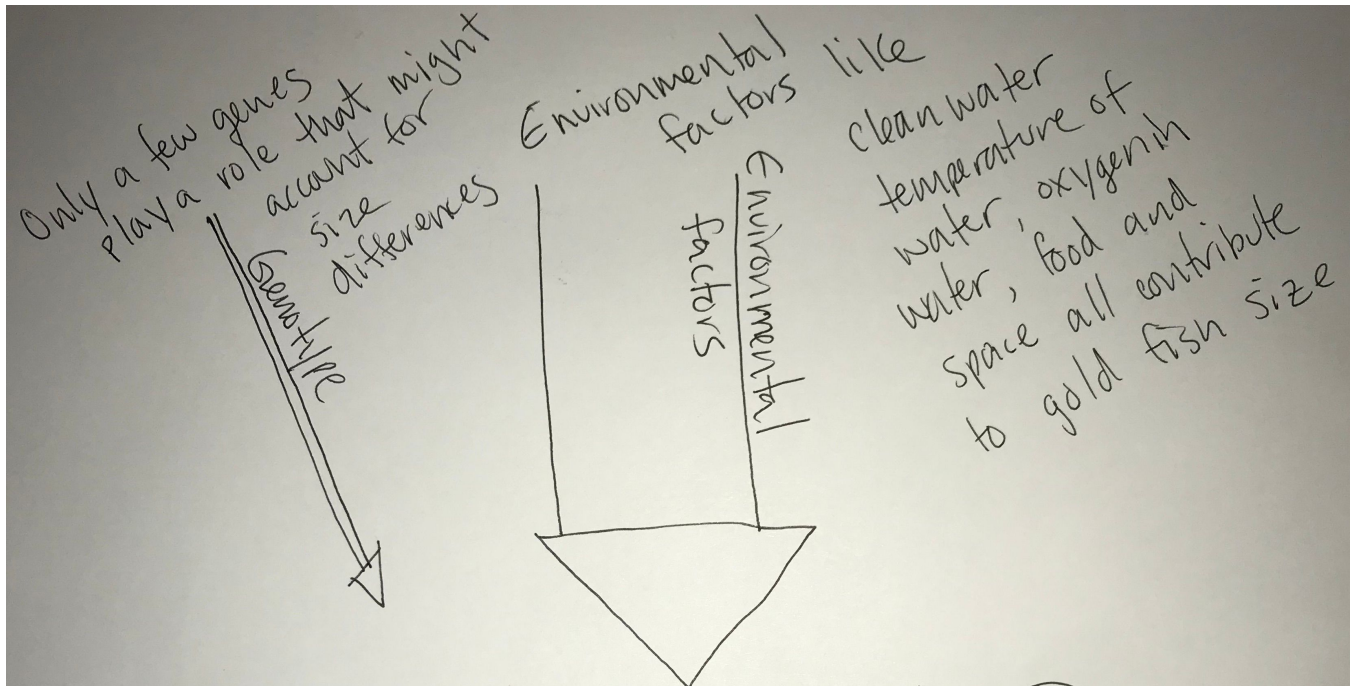
+ Model includes genotype and environmental factors.
+ Both genotype and environmental factors are shown interacting with the range of goldfish size.
+ Environmental factors are shown to have a much larger influence on goldfish size relative to genotype.