

BEETLE GENETICS INVESTIGATION STEM INVESTIGATION

**Print-and-go STEM
lab where students
learn heredity using
beetles: alleles,
Punnett squares,
genotype/phenotype,
probability, and a
dihybrid cross.**

Beetle Genetics Investigation: Punnett Squares & Traits

Purpose
Teach heredity with beetles: alleles, Punnett squares, genotype/phenotype, probability, and a dihybrid cross.

- Learning Objectives**
- Differentiate genotype vs phenotype; dominant vs recessive.
 - Use Punnett squares to predict genotype and phenotype ratios (monohybrid).
 - Calculate expected probabilities and compare to outcomes.
 - Extend to a dihybrid cross ($AaBb \times AaBb$).
 - Write a short CER using results.

- Materials**
- Printed Parent Genotype Cards (A/a, B/b, C/c, D/d, E/e) — two decks
 - Student packet (Punnett grids and ratio tables)
 - Colored pencils/markers
 - Scissors, tape/glue

Background Science for the Teacher
Each trait has two alleles (dominant/recessive). Offspring receive one allele from each parent; Punnett squares organize combinations and ratios. Probability describes chance per offspring; small samples vary from expectations.

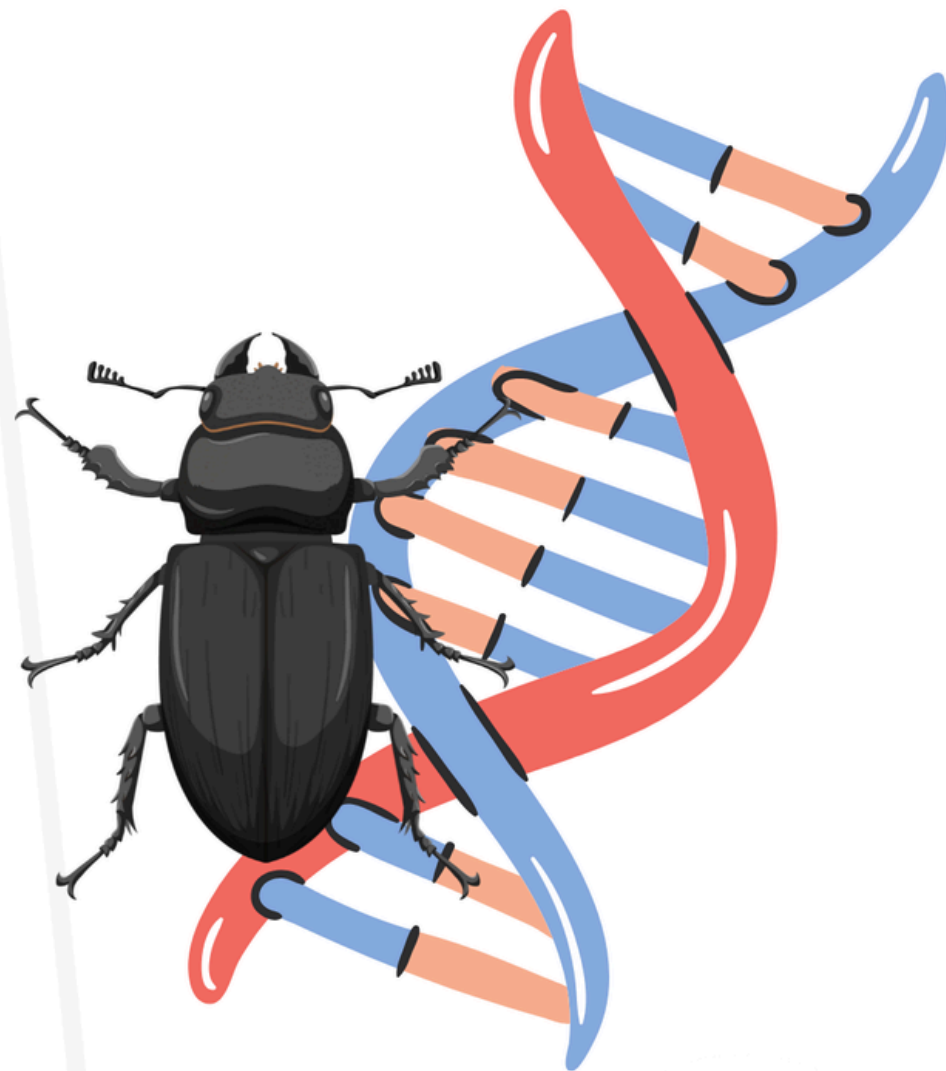
- Variables**
- Independent Variable: Parent genotypes (allele pairs chosen).
 - Dependent Variable: Offspring genotype/phenotype ratios.
 - Controlled Variables: Dominance rules, list of traits, consistent procedure.

Expected Results Pattern
 $Aa \times Aa \rightarrow$ genotype 1:2:1, phenotype 3:1; $AaBb \times AaBb \rightarrow$ phenotype 9:3:3:1 (independent assortment).

- Implementation Notes**
- Run 4–5 traits; begin with a single monohybrid.
 - Students draw Parent 1 and Parent 2 from each gene deck (A–E).
 - Require labeled grids, ratios, and CER; share-out to compare patterns.

- Extension Ideas**
- Add one incomplete-dominance trait with three phenotypes.
 - Coin-flip allele model to visualize sampling error.
 - Introduce pedigrees after Punnett mastery.

- Teacher Notes on Common Pitfalls and Fixes**
- Confusing genotype/phenotype $\rightarrow$ keep a reference box visible.
 - Unlabeled alleles on grid edges $\rightarrow$ model an example live.
 - Treating ratios as guarantees $\rightarrow$ emphasize probability.



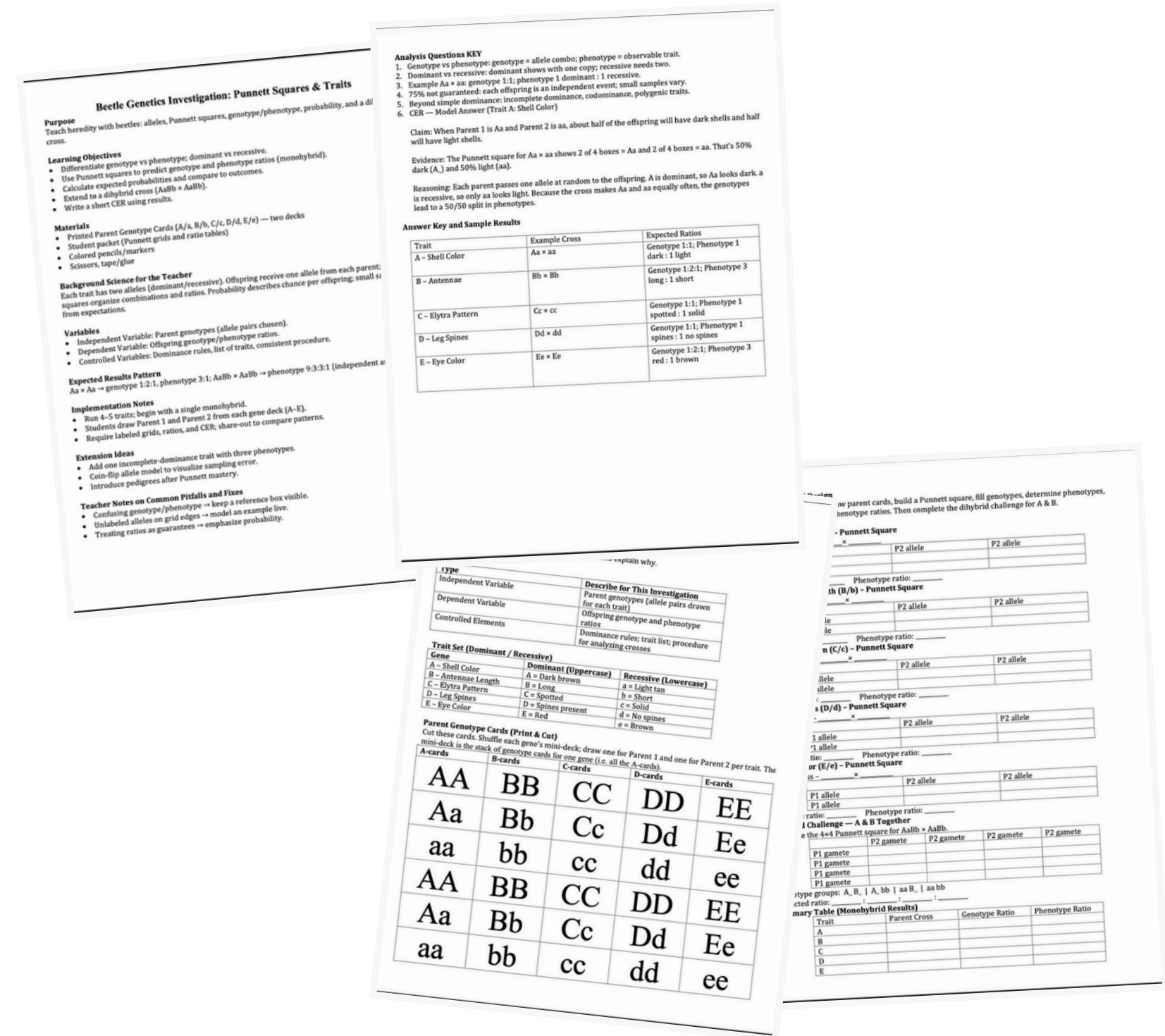
SCROLL
to take a look inside!



HOW THIS LAB WILL HELP YOU

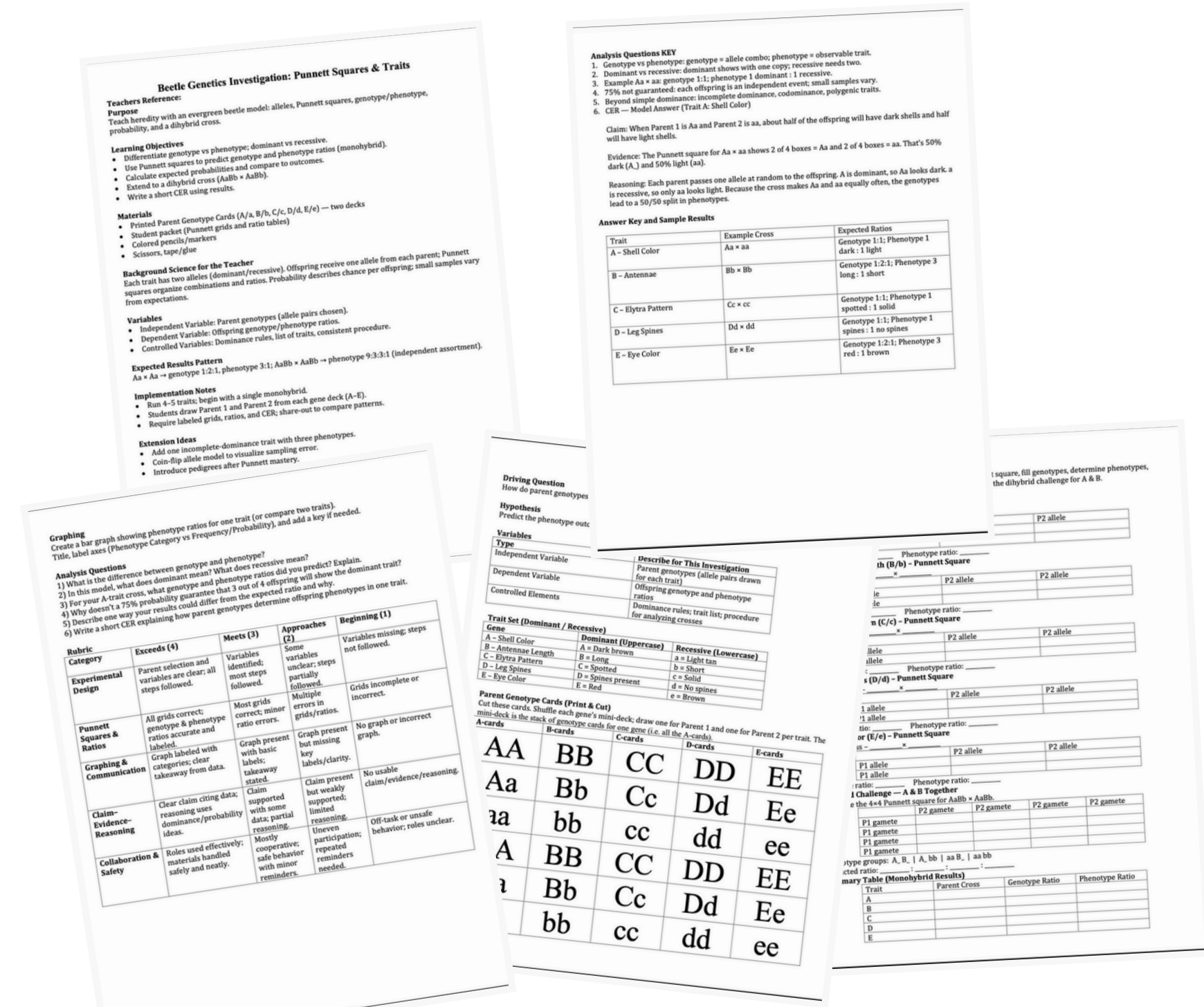


- Print-and-go setup
- Clear Testing Procedure
- Data & math supports
- Low-cost & common materials

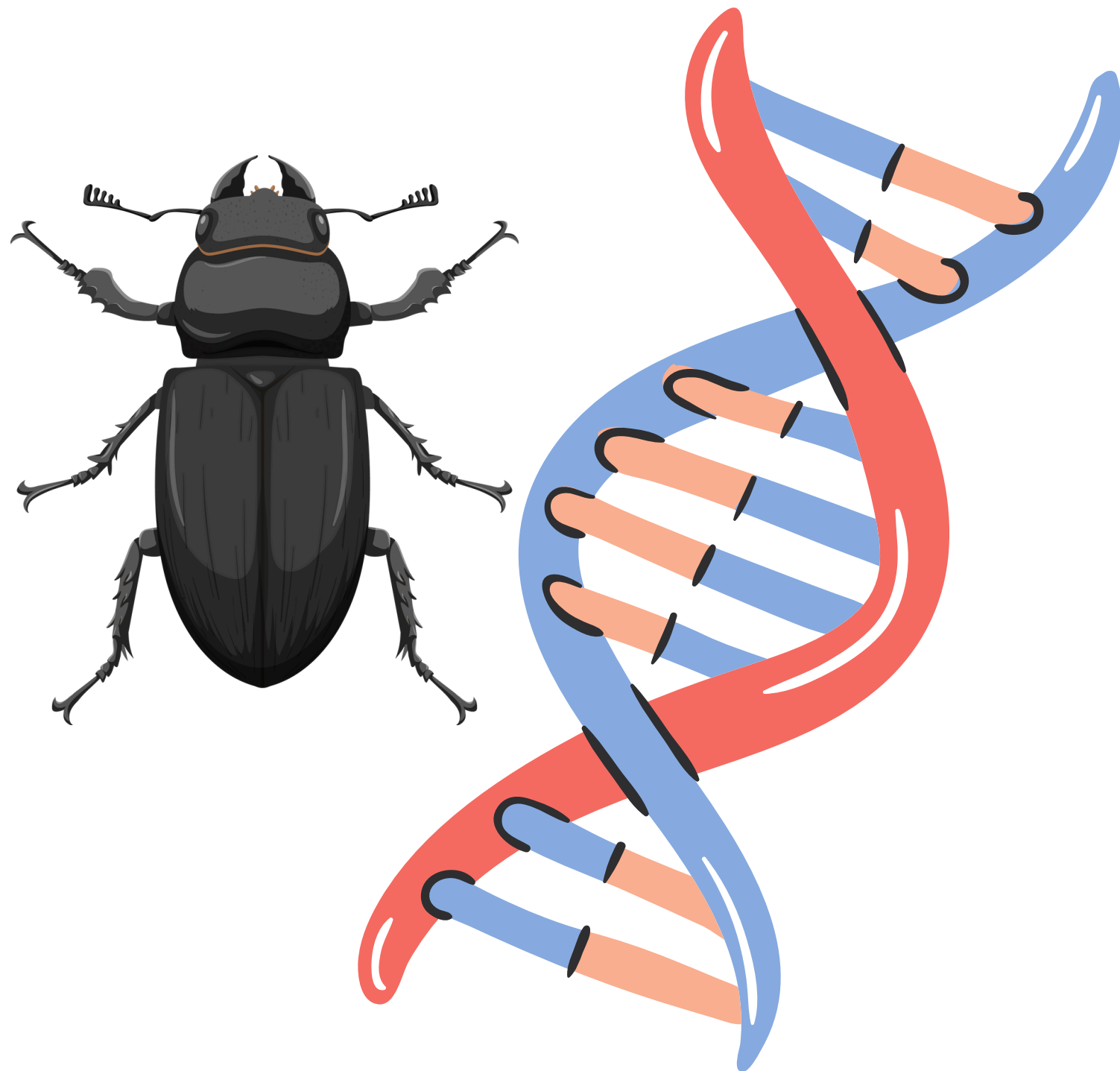


Complete answer key with example data tables.

What you get inside



Skills Your Students Will Learn/Improve



- ✓ Carrying out Controlled Experiments
- ✓ Precise Measurement
- ✓ Design and Redesign
- ✓ Graphing Data
- ✓ Claim–Evidence–Reasoning
- ✓ Analyzing Results

Your Lab

All steps are clearly outlined and easy to follow

Students collect data in organized charts

Graphing

Students analyze their data and draw conclusions

Beetle Genetics STEM Investigation:

Driving Question

How do parent genotypes determine offspring traits in beetles?

Hypothesis

Predict the phenotype outcomes for one trait and explain why.

Variables

Type	Describe for This Investigation
Independent Variable	Parent genotypes (allele pairs drawn for each trait)
Dependent Variable	Offspring genotype and phenotype ratios
Controlled Elements	Dominance rules; trait list; procedure for analyzing crosses

Trait Set (Dominant / Recessive)

Gene	Dominant (Uppercase)	Recessive (Lowercase)
A – Shell Color	A = Dark brown	a = Light tan
B – Antennae Length	B = Long	b = Short
C – Elytra Pattern	C = Spotted	c = Solid
D – Leg Spines	D = Spines present	d = No spines
E – Eye Color	E = Red	e = Brown

Parent Genotype Cards (Print & Cut)

Cut these cards. Shuffle each gene's mini-deck; draw one for Parent 1 and one for Parent 2 for each trait. The mini-deck is the stack of genotype cards for one gene (i.e. all the A-cards).

A-cards	B-cards	C-cards	D-cards	E-cards
AA	BB	CC	DD	EE
Aa	Bb	Cc	Dd	Ee
aa	bb	cc	dd	ee
AA	BB	CC	DD	EE
Aa	Bb	Cc	Dd	Ee
aa	bb	cc	dd	ee

Graphing

Create a bar graph showing phenotype ratios for one trait (or compare two traits). Title, label axes (Phenotype Category vs Frequency/Probability), and add a key if needed.

Analysis Questions

- 1) What is the difference between genotype and phenotype?
- 2) In this model, what does dominant mean? What does recessive mean?
- 3) For your A-trait cross, what genotype and phenotype ratios did you predict? Explain.
- 4) Why doesn't a 75% probability guarantee that 3 out of 4 offspring will show the dominant trait?
- 5) Describe one way your results could differ from the expected ratio and why.
- 6) Write a short CER explaining how parent genotypes determine offspring phenotypes in one trait.

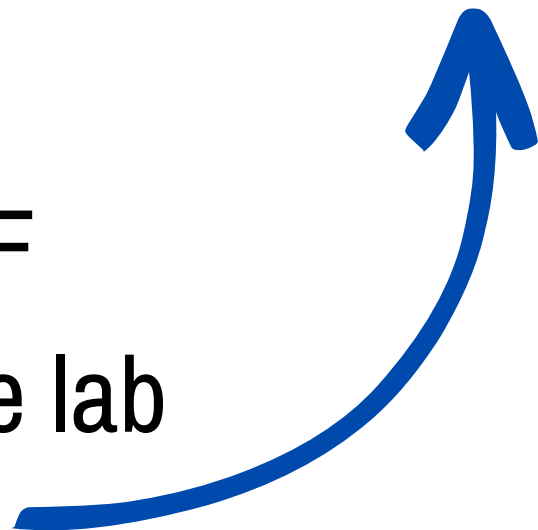
Rubric

Category	Exceeds (4)	Meets (3)	Approaches (2)	Beginning (1)
Experimental Design	Parent selection and variables are clear; all steps followed.	Variables identified; most steps followed.	Some variables unclear; steps partially followed.	Variables missing; steps not followed.
Punnett Squares & Ratios	All grids correct; genotype & phenotype ratios accurate and labeled.	Most grids correct; minor ratio errors.	Multiple errors in grids/ratios.	Grids incomplete or incorrect.
Graphing & Communication	Graph labeled with categories; clear takeaway from data.	Graph present with basic labels; takeaway stated.	Graph present but missing key labels/clarity.	No graph or incorrect graph.
Claim-Evidence-Reasoning	Clear claim citing data; reasoning uses dominance/probability ideas.	Claim supported with some data; partial reasoning.	Claim present but weakly supported; limited reasoning.	No usable claim/evidence/reasoning.
Collaboration & Safety	Roles used effectively; materials handled safely and neatly.	Mostly cooperative; safe behavior with minor reminders.	Uneven participation; repeated reminders needed.	Off-task or unsafe behavior; roles unclear.

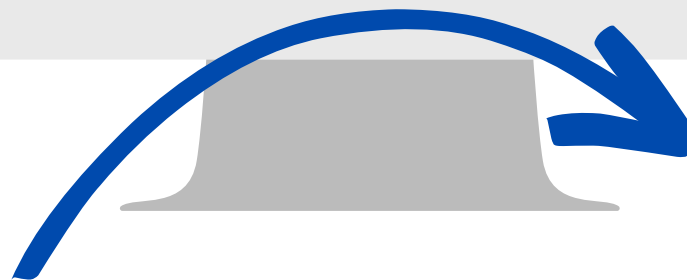
At School or at Home



Word and PDF
versions of the lab



Fully digital and editable - can be
done in class or through distance
education/homeschool



Ways to Use this Resource



Introduce the Scientific Method



Reinforce key ideas



Teach data analysis and graphing



Formative or Summative Assessment

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Background Science for the Teacher
Each trait has two alleles (dominant/recessive). Offspring receive one allele from each parent; squares organize combinations and ratios. Probability describes chance per offspring; small samples may vary from expectations.

Variables

- Independent Variable: Parent genotypes (allele pairs chosen).
- Dependent Variable: Offspring genotype/phenotype ratios.
- Controlled Variables: Dominance rules, list of traits, consistent procedure.

Expected Results Pattern
Aa × Aa → genotype 1:2:1, phenotype 3:1; AaBb × AaBb → phenotype 9:3:3:1 (independent assortment)

Implementation Notes

- Run 4-5 traits; begin with a single monohybrid.
- Students draw Parent 1 and Parent 2 from each gene deck (A-E).
- Require labeled grids, ratios, and CER; share-out to compare patterns.

Extension Ideas

- Add one incomplete-dominance trait with three phenotypes.
- Coin-flip allele model to visualize sampling error.
- Introduce pedigrees after Punnett mastery.

Teacher Notes on Common Pitfalls and Fixes

- Confusing genotype/phenotype → keep a reference box visible.
- Unlabeled alleles on grid edges → model an example live.
- Treating ratios as guarantees → emphasize probability.

Analysis Questions KEY

- Genotype vs phenotype: genotype = allele combo; phenotype = observable trait.
- Dominant vs recessive: dominant shows with one copy; recessive needs two.
- Example Aa × aa: genotype 1:1; phenotype 1 dominant : 1 recessive.
- 75% not guaranteed: each offspring is an independent event; small samples vary.
- Beyond simple dominance: incomplete dominance, codominance, polygenic traits.
- CER — Model Answer (Trait A: Shell Color)

Claim: When Parent 1 is Aa and Parent 2 is aa, about half of the offspring will have dark shells and half will have light shells.

Evidence: The Punnett square for Aa × aa shows 2 of 4 boxes = Aa and 2 of 4 boxes = aa. That's 50% dark (A_) and 50% light (aa).

Reasoning: Each parent passes one allele at random to the offspring. A is dominant, so Aa looks dark. a is recessive, so only aa looks light. Because the cross makes Aa and aa equally often, the genotypes lead to a 50/50 split in phenotypes.

Answer Key and Sample Results

Trait	Example Cross	Expected Ratios
A - Shell Color	Aa × aa	Genotype 1:1; Phenotype 1 dark : 1 light
B - Antennae	Bb × Bb	Genotype 1:2:1; Phenotype 3 long : 1 short
C - Elytra Pattern	Cc × cc	Genotype 1:1; Phenotype 1 spotted : 1 solid
D - Leg Spines	Dd × dd	Genotype 1:1; Phenotype 1 spines : 1 no spines
E - Eye Color	Ee × Ee	Genotype 1:2:1; Phenotype 3 red : 1 brown

Beetle Genetics STEM Investigation:

Driving Question
How do parent genotypes determine offspring traits in beetles?

Hypothesis
Predict the phenotype outcomes for one trait and explain why.

Variables

Independent Variable	Describe for This Investigation (allele pairs drawn for each trait)
Parent genotypes	Parent genotypes (allele pairs drawn for each trait)
Dependent Variable	Offspring genotype and phenotype ratios
Controlled Elements	Dominance rules; trait list; procedure for analyzing crosses

Alleles (Dominant / Recessive)

Color	Dominant (Uppercase)	Recessive (Lowercase)
Color	A = Dark brown	a = Light tan
Antenna Length	B = Long	b = Short
Elytra Pattern	C = Spotted	c = Solid
Leg Spines	D = Spines present	d = No spines
Eye Color	E = Red	e = Brown

Genotype Cards (Print & Cut)
Shuffle each gene's mini-deck; draw one for Parent 1 and one for Parent 2 per trait. The rest of the deck is the stack of genotype cards for one gene (i.e., all the A-cards).

Genotype Cards

B-cards	C-cards	D-cards	E-cards
BB	CC	DD	EE
Bb	Cc	Dd	Ee
bb	cc	dd	ee
BB	CC	DD	EE
Bb	Cc	Dd	Ee
bb	cc	dd	ee

Punnett Square

Draw parent cards, build a Punnett square, fill genotypes, determine phenotypes, genotype ratios. Then complete the dihybrid challenge for A & B.

Monohybrid (B/b) - Punnett Square

P2 allele	P2 allele
a	a
A	a
a	a
A	a

Phenotype ratio: _____

Dihybrid (B/b, D/d) - Punnett Square

P2 allele	P2 allele
b	d
B	d
b	d
B	d

Phenotype ratio: _____

Challenge — A & B Together
Use the 4×4 Punnett square for AaBb × AaBb.

P1 gamete	P2 gamete	P2 gamete	P2 gamete
P1 gamete			
P1 gamete			
P1 gamete			
P1 gamete			

Genotype groups: A_ B_ | A_ bb | aa B_ | aa bb

Phenotype ratio: _____

Summary Table (Monohybrid Results)

Trait	Parent Cross	Genotype Ratio	Phenotype Ratio
A			
B			
C			
D			
E			



Download my Angle of Attack STEM Lab FREE
CLICK HERE

✓ Teacher guide with setup, safety, background science, pacing

✓ Step-by-step procedure for testing

✓ Analysis questions with model answers and Rubric



Paper Airplane Angle of Attack STEM Lab

Scientific Method • Variables • Data & Graphing

✓ Classroom-Ready

✓ Data tables + bar graph templates included



Paper Airplane: Angle of Attack STEM Investigation: Scientific Method Activity

Teachers Reference:

Angle of Attack Explained - <https://youtu.be/D1J1oUP-aKA?si=vsnb9a72PajoWnZs>



Purpose

Use a high-engagement paper-airplane challenge to teach experimental design, variables and controls, proportional reasoning, data analysis, and communication of results.

Learning Objectives

- Plan and carry out a controlled investigation with clear independent, dependent, and controlled variables.
- Collect sufficient data (replicates) and compare results across angle conditions.
- Graph distance data to analyze trends and construct evidence-based claims.
- Explain the physical principles (lift, drag, stall) that affect flight distance.

only airplanes; no paper clips or sharp nose cones.
a clear launch lane; stand behind the throw line; throw parallel to the floor.
ing area clear; retrieve planes only after all throws in a round are complete.

- 8.5×11 in) — identical for all planes
- and template (optional, one standard design for all teams)
- factor (or angle guides) to set release angle relative to horizontal
- Tape for a throw line and distance marks; measuring tape or meter tape
- Data sheets (included), clipboards, pencils

Background Science for the Teacher

Lift vs Angle of Attack (AoA): Lift generally increases with AoA up to a point. Beyond a critical AoA, airflow separates (stall), causing lift to drop and drag to rise, shortening distance.

Drag and Energy: Higher AoA increases frontal area and induced drag; too much drag slows the plane quickly. Moderate AoA balances adequate lift with manageable drag for a longer glide.

Consistency: A single plane design, constant throw force/height, and a clear angle-setting method are key to fair comparisons.

Expected Results Pattern

- Distances typically peak at a moderate AoA (around 10°–15° for a simple dart design).
- Very low AoA (0°–5°) may dive or fail to generate a strong glide; very high AoA (20°+) often stalls or climbs then falls rapidly.
- As throw technique becomes consistent, variation decreases and the distance curve vs angle becomes clearer.

Implementation Notes

- Use one standard airplane design per class for consistency (provide a template or model).
- Assign roles: Thrower, Angle Setter/Checker, Measurer, Recorder. Rotate roles between angles.
- Mark the throw line and measure angle at release using a protractor or an angle card taped to the forearm or launcher guide.

Answer Key and Sample Results

Note: Actual class data will vary. The sample below models typical trends and acceptable analysis quality.

Sample Summary Data

Angle (°)	Average Distance (m)
0	7.8
5	10.6
10	12.9
15	12.1
20	8.9

Interpretation

- Greatest average distance at 10° (=12.9 m) with a close second at 15° (=12.1 m).
- Very low angle (0°) underperformed (dives/low lift). Very high angle (20°) lost distance (near-stall and higher drag).
- The trend supports a moderate-angle optimum due to balance of lift and drag.

Model Responses to Analysis Questions

- Best angle: 10° with an average of ~12.9 m (our class graph shows a peak around 10–15°).
- Consistency: Results were reasonably consistent after the practice round; using the same thrower and angle card reduced variation.
- Controls that mattered most: Plane design and paper type, release height and throw force, indoor/no-draft room, and measuring to first contact.
- Follow-up: Test nose mass with paper clips at the best angle. Hypothesis: Adding a small nose mass (1–2 clips) will increase distance by improving stability without greatly increasing drag.

STEM INVESTIGATION BUNDLE

Build a high-engagement, low-prep STEM program.

- This Bundle includes my best STEM investigations—each one built around true engineering design, fair testing, repeated trials, data tables, graphing, and CER writing.
- STEM develops crucial skills like critical thinking and creativity and prepares students for a changing world and future opportunities.



Tell me and I forget. Teach me and I remember. Involve me and I learn. - Benjamin Franklin



STEM Investigation Growing Bundle

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✓ A Variety of Science Topics Included



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thanks
**for your interest
in this resource!**

