Agricultural Biotechnology

Nebraska Career Development Event
Handbook and Rules 2020-2024

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1. Event Purpose

a. The purpose of the agricultural biotechnology career development event is to encourage students to explore the diversity of the Biotechnology Industry, in terms of basic knowledge, skills and applications of biotechnology to the workplace. The areas of agricultural biotechnology have important implications for the animal, plant, food, and pharmaceutical industries.

b. Agriculture Education courses that align with the agricultural biotechnology CDE include: Introduction to Agriculture, Food and Natural Resources; Plant Science; Horticulture; Plant Biology; Natural Resources; Biotechnology; Nursery and Landscape; Food Science; Advanced Food Science; Agronomy; and UNL AGRI 115 (link-https://bulletin.unl.edu/undergraduate/courses/AGRI/115).

2. CDE Objectives

a. Team Practicum Objectives:
    i. Research the practicum problem formulated from the annual theme.
    ii. Describe the process of genetic engineering; designing a gene, transformation, breeding, and DNA testing.
    iii. Develop a genetic engineering plan and a breeding plan that solves the practicum problem based around the annual theme.
    iv. Create a hand drawn poster.
b. Identification Objectives:
    i. Identify equipment and tool(s) utilized in agricultural biotechnology systems.
c. Test Objectives:
    i. Define key concepts related to biotechnology and genetic engineering, such as, but not limited to: cellular makeup, organelle functions, mitosis, plant anatomy, organism reproduction.
    ii. Relate the concepts of biotechnology and genetic engineering to the agriculture industry, such as but not limited to: genetic engineering methods, naturally occurring processes, selective breeding.
    iii. Identify the steps necessary to develop genetically engineered organisms such as the steps outlined in the Journey of a Gene resource materials.

3. Eligibility

a. The top two teams per district may compete at the state CDE.
b. This event is open to students in grades 9-12.
c. A maximum of four students per team may participate.

4. Recommended Attire

a. Official FFA Dress or other professional attire is strongly recommended for this event.

5. Required Supplies & Equipment

a. Pencils, at least one per student
b. One “clean” clipboard without notes, per student.
c. One laptop computer or tablet per team for use during the practicum.
d. No smartphones will be permitted during the practicum.
e. After arriving on-campus, students should request Guest Wireless Access before the Ag Biotechnology contest begins.
    i. Use link to connect to WiFi- https://its.unl.edu/services/wi-fi/

6. Event Schedule

a. Teams will be divided into two groups.
    i. Group 1 will start with the Team Practicum, lasting 60 minutes.
    ii. Group 2 will start with the individual components and be subdivided into the individual test and individual identification sections. Each individual section will last 30 minutes before rotating.
    iii. After 60 minutes, teams will rotate to the opposite group.

7. Annual Theme

a. The annual themes will rotate between plants and animals. Specific theme information will be provided by September 15th of each year.
    i. 2020 - Plant (Arctic Apples)
    ii. 2021 - Animal (Genetically modified cattle)
    iii. 2022 - Plant
    iv. 2023 - Animal
    v. 2024 - Plant

8. Event Format

a. Individual Written Test
    i. The written test is designed to evaluate participants’ knowledge in biological concepts related to the biotechnology industry. The test will consist of 50 multiple choice and/or true/false questions which require the application of biological principles.
    ii. Test may be presented either on a computer or on a bubble sheet.
    iii. Students must provide pencil for the written test.

iv. Scratch paper will be provided.
v. Students will have 30 minutes to complete this section.
vi. Contestants will be allowed to work at their own pace.

b. Individual Identification of Materials and Tools
   i. Twenty-five specimens will be selected from the materials and tools listed on the Identification List.
   ii. Specimens will be identified on an individual basis, with 30 minutes.
   iii. Materials and tools to identify will be presented as intact specimens, models, or high quality photographs.
   iv. Each specimen will be designated with a number. Students fill in the answer sheet with the appropriate number in the space next to the specimen's name on the official scorecard.
   v. Two points will be given for each correctly identified specimen.
   vi. Under no circumstances is any student allowed to touch or handle the photos or specimens used as part of the event. Any infraction of this policy is sufficient cause to eliminate the individual from the entire contest. Any contestant looking at the identification form of another contestant will be automatically disqualified.

c. Team Activity Practicum
   i. Students are presented a problem, conduct research with their laptop or tablet about how to solve the problem, and then will create a poster or other written media to convey their solution to the problem.
   ii. Teams are provided markers, poster-size paper, and the practicum packet of information about the problem.
   iii. The written presentation of their solution is evaluated for the team score.
   iv. Utilize rubric and example in appendix for guidance.

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9. Scoring

Individual

Event	Individual Points

Individual Score Calculation

Written Examination	(50 questions x 2 points)	100
Identification Practicum	(25 items x 2 points)	50
Total Individual Score		**150**

Team

Event	Team Points
Team Score Calculation	
Total of 4 Individual Scores	600
Team Practicum Score	400
Total Team Score	**1,000**

10. Tiebreaker

a. Individual
   i. Test Score
   ii. Identification Score
   iii. Team Practicum Score
b. Team
   i. Team Practicum Score
   ii. Combined Individual Test Scores
   iii. Combined Individual Identification Scores

11. Resource Materials

a. The Journey of a Gene website (https://ge.unl.edu/journey-of-a-gene), including the 'Test Your Knowledge' section which includes resource materials, quizzes, exams, practicum, identification flashcards, is the best resource to prepare for the event.
b. Relevant resources / websites per the rotating topic will be provided on the CDE website when the annual specific theme is announced.
c. Suggested resources for background knowledge for teaching biotechnology
   - CK12 Biotechnology - Introduction reading
     - https://go.unl.edu/ck12biotech
   - CK12 Biotechnology Advanced - Another reading
     - https://go.unl.edu/ck12biotech-advanced
   - Khan Academy Introduction to Genetic Engineering Lesson

        - https://go.unl.edu/khanacademy-introgeneticengineering
    - Introduction of Genetic Engineering and Its Applications
        - https://go.unl.edu/genetic-engineering
    - Chapter 7 Genetically Engineered Crops - Teacher Resource
        - https://www.nap.edu/read/23395/chapter/10
    - How to Make a GMO - this one has a great diagram
        - https://go.unl.edu/howtomakeagmo
    - Basic Biotechnology Plant and Soil Science eLibrary
        - https://go.unl.edu/basicbiotechplant-soil
    - Segregation of Genes: The Plant Breeder's Method for Predicting the Future
        - https://go.unl.edu/segregationofgenes

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12. Past Exams

a. Past exams will not be provided.

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13. Post-CDE debriefing opportunity and criteria

a. A walk through debriefing is not available.
b. Teams will receive their posters in their award and critique packets.

APPENDIX

List of items in the appendix:

Appendix 1: Identification List 8

Appendix 2: Identification Form Example 9

Appendix 3: Team Practicum Rubric 10

Appendix 1 - Identification List

1. DNA
2. Micro-Pipet
3. DNA extraction
4. Pipetting a sample
5. Electrophoresis casting tray
6. Water Bath
7. Electrophoresis
8. Agar gel
9. Beaker
10. Graduated cylinder
11. Protein test strip
12. Forceps
13. Thermal cycler
14. Petri dish
15. Incubator
16. Punnett Square
17. Micro-Centrifuge Tubes
18. Centrifuge
19. Hand planter
20. Microscope Slides
21. Microscope
22. Hotplate
23. Balance Scale
24. Sepal
25. Anther
26. Filament
27. Stamen
28. Pistil
29. Style
30. Stigma
31. Ovary
32. Ovule
33. Silk
34. Tassel
35. Pollen
36. Tassel bag
37. 37. Shoot bag
38. Central Vacuole
39. Nucleus
40. Gene
41. Chromosomes
42. Fertilized egg cell
43. Frozen male gametes
44. Gene gun
45. Cross pollination
46. Tissue culture
47. Detasseling
48. Corn hybrid production field
49. Particle acceleration
50. Mortar and pestle

EXAMPLE - Ag. Biotechnology CDE Identification Sheet

Name: _____ **Chapter:**_____

Each letter with a blank corresponds to an item in the room. Write the number of the correct word from the word bank on the blank of the letter for the corresponding item.

A. _____
B. _____
C. _____
D. _____
E. _____
F. _____
G. _____
H. _____
I. _____
J. _____
K. _____
L. _____
M. _____
N. _____
O. _____
P. _____
Q. _____
R. _____
S. _____
T. _____
U. _____
V. _____
W. _____
X. _____
Y. _____

Word bank

1. DNA
2. Micro-Pipet
3. DNA extraction
4. Pipetting a sample
5. Electrophoresis casting tray
6. Water Bath
7. Electrophoresis
8. Agar gel
9. Beaker
10. Graduated cylinder
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14. Petri dish
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16. Punnett Square
17. Micro-Centrifuge Tubes
18. Centrifuge
19. Hand planter
20. Microscope Slides
21. Microscope
22. Hotplate
23. Balance Scale
24. Sepal
25. Anther
26. Filament
27. Stamen
28. Pistil
29. Style
30. Stigma
31. Ovary
32. Ovule
33. Silk
34. Tassel
35. Pollen
36. Tassel bag
37. Shoot bag
38. Central Vacuole
39. Nucleus
40. Gene
41. Chromosomes
42. Fertilized egg cell
43. Frozen male gametes
44. Gene gun
45. Cross pollination
46. Tissue culture
47. Detasseling
48. Corn hybrid production field
49. Particle acceleration
50. Mortar and pestle

Appendix 3: Team Practicum Poster Rubric

Requirements	Points
Biotechnology company name is unique, creative and prominently displayed.	20 points
Promote the benefit of this new trait for people.	30 points
Genetic Engineering steps have been clearly identified and are specific to the focus organism.	120 points
Breeding steps show how to make desired organism, Include Punnett squares to show how breeders will achieve the end goal	140 points
Describe at least one scientific and one non-scientific challenge or issue related to this genetically engineered organism.	50 points
Team produced clear, organized and visually attractive poster.	40 points

Biotechnology CDE Practicum 2017

Practicum Rules (400 points/team)

1. This practicum is designed to evaluate participants' ability to analyze a problem set using information provided. The practicum may include a combination of the following:

    - Utilizing biological information
    - Research (onsite) a situation relevant to the biotechnology industry
    - Determining supporting facts in solving the situation
    - Justify the credibility of their resources.

    For the practicum portion of the contest, team members will be asked to find and distill information, utilizing resources provided, rather than memorize information.

2. Research resources and blank paper will be provided.
3. Students will have 60 minutes to complete this section. Contestants will be allowed to work at their own pace.
4. Students will work, as a team, on the practicum and put together a written presentation (ex. poster, brochure). The written presentation will be scored following the CDE.

Practical Problem with a Genetic Engineering Solution

Fig. 1: AquAdvantage Salmon is equivalent to Atlantic salmon in flavor
(AquaBounty website https://aquabounty.com/our-salmon/)

Fig. 2: Salmon steak, high in Omega-3's
(*"salmon" by randychiu is licensed under CC BY 2.0*)

Fig. 3: Ocean pout contributed to GE process
(Scott Leslie, Nature Picture Library, 2008)

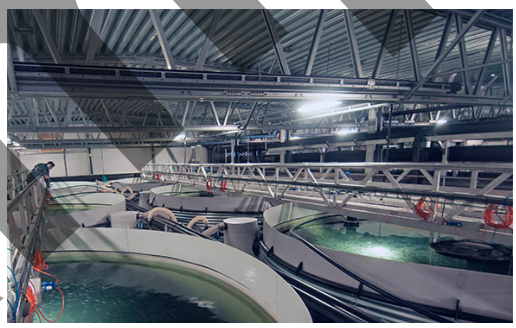


Fig. 4: Aquaculture facility where the AquAdvantage Salmon are grown.
(Kruger Kaldnes RAS & Veolia Water Technologies)

Demand for salmon in our food production system continues to increase. Large amounts of what is purchased at the store is farmed in facilities rather than caught in the wild. Salmon is often a food of choice based on its health benefits – source of protein, essential vitamins and minerals and Omega-3 polyunsaturated fatty acids.

Traditional fish farming practices when raising salmon include placing cages in lakes and the ocean to facilitate salmon growth. This process of raising salmon from egg to adult ready for the food market can take about three years. Atlantic salmon are a very commonly consumed by people due to its flavor, texture and nutritional value.

Increasing the growth-rate in salmon has the potential to make salmon farming more profitable and provide more salmon for the consumer market, thus reducing the cost of this product. The growth-rate in salmon can be increased by the addition of growth hormone to the fish feed or by creating fish that produce a higher level of growth hormone in their body. The Atlantic salmon, Chinook salmon and Ocean Pout all contributed to the process of developing genetically engineered AquAdvantage salmon.

Your assignment is to:

1. Create a genetic engineering plan to develop a type of salmon that grows faster than non-transgenic salmon.

2. Develop a breeding plan to combine this growth-rate trait with other traits the salmon farmers want in the Atlantic salmon they raise on their aquaculture farm.

Your team has 60 minutes to complete the following:

1. Create a name for your biotechnology company.

2. Research via the Internet "AquAdvantage Salmon" to learn specific details about the gene that was introduced.

3. Use "Journey of a Gene" or other resources to determine a transformation method.

4. **Outline** the steps the scientists performed to develop the genetically engineered salmon.

5. **Outline** a breeding plan that will result in a group of Atlantic salmon which all have the growth-rate gene, disease resistance and high Omega-3 level traits. Use Punnett squares to predict the inheritance of genes in the breeder's salmon.

NOTE: See information below. Assume these are the three main genetic differences among the Atlantic salmon breeds you could choose to use in the breeding part of your plan.

6. Identify potential scientific and non-scientific challenges to your project's success. **List** how your biotechnology company will address these challenges.

The homozygous growth-rate hormone line from the genetic engineer: **AAhhii**
An Atlantic salmon breed homozygous for a disease resistance trait: **aaHHii**
An Atlantic salmon breed homozygous for a trait with high Omega-3 levels: **aahhII**

'A' is the transgene introduced by the genetic engineers to encode a growth-rate hormone. Salmon that are '**aa**' do not have this transgene in their chromosome.

HH and **Hh** salmon are resistant to a disease that the fish farmer wants to prevent in his salmon stock. Salmon that are **hh** are susceptible to the disease and may die.

II and Ii salmon have higher levels of Omega-3's compared with **ii** salmon.

*Use Punnett squares to predict the inheritance of all genes.

Check list and Work sheet: Turn this in with your team's outline and lists

Team points (400 possible)

The following items/categories need to be included in the final hand drawn poster for the practicum.

1. 20 points: Biotechnology company name is unique, creative and prominently displayed
2. 30 points: Promote the benefit of this new trait for people.
3. 120 points: Genetic Engineering steps have been clearly identified and are specific to the focus organism.
4. 140 points: Breeding steps show how to make the desired organism. Include Punnett squares to show how breeders will achieve the end goal.
5. 50 points: Describe at least one scientific and one non-scientific challenge or issue related to this genetically engineered organism.
6. 40 points: Team produced a clear, organized and visually attractive poster.

Team work checklist

___ Company name

___Research important facts

___Organize and draw your steps for GE outline

___Organize and draw your salmon breeding process to get your final desired outcome. Use appropriate Punnett squares.

___ Benefits of your successful project.

___ Issues and concerns (scientific and non-scientific) and how you will address them.

___ Verify that all parts of the practicum have been addressed on the poster.

AquAdvantage Salmon Practicum Answer key (optimal answer, pictures pages follow this)

1. 20 pts: Biotechnology company name is unique, creative and prominently displayed

2. 30 pts: The benefit is that Atlantic Salmon grown on farms grow faster, have high quality meat and can be raised with a higher level of cost efficiency.

3. 120 pts: Genetic Engineering steps (see next page for figure of optimal answer)
   - Identify large and fast-growing species of Salmon as source of the growth hormone gene.
   - Promoter should be specified that turns on the gene in correct body part(s).
   - Gene introduced by injection into fertilized Atlantic Salmon eggs.
   - Eggs hatched to produce fry.
   - Select and breed the Atlantic Salmon (a male and female) that received the transgene and express it.

4. 140 pts: Salmon Breeding steps

   Use Punnett squares to show breeding plan.

   - **See options for breeding plans with Punnett squares on following pages.**

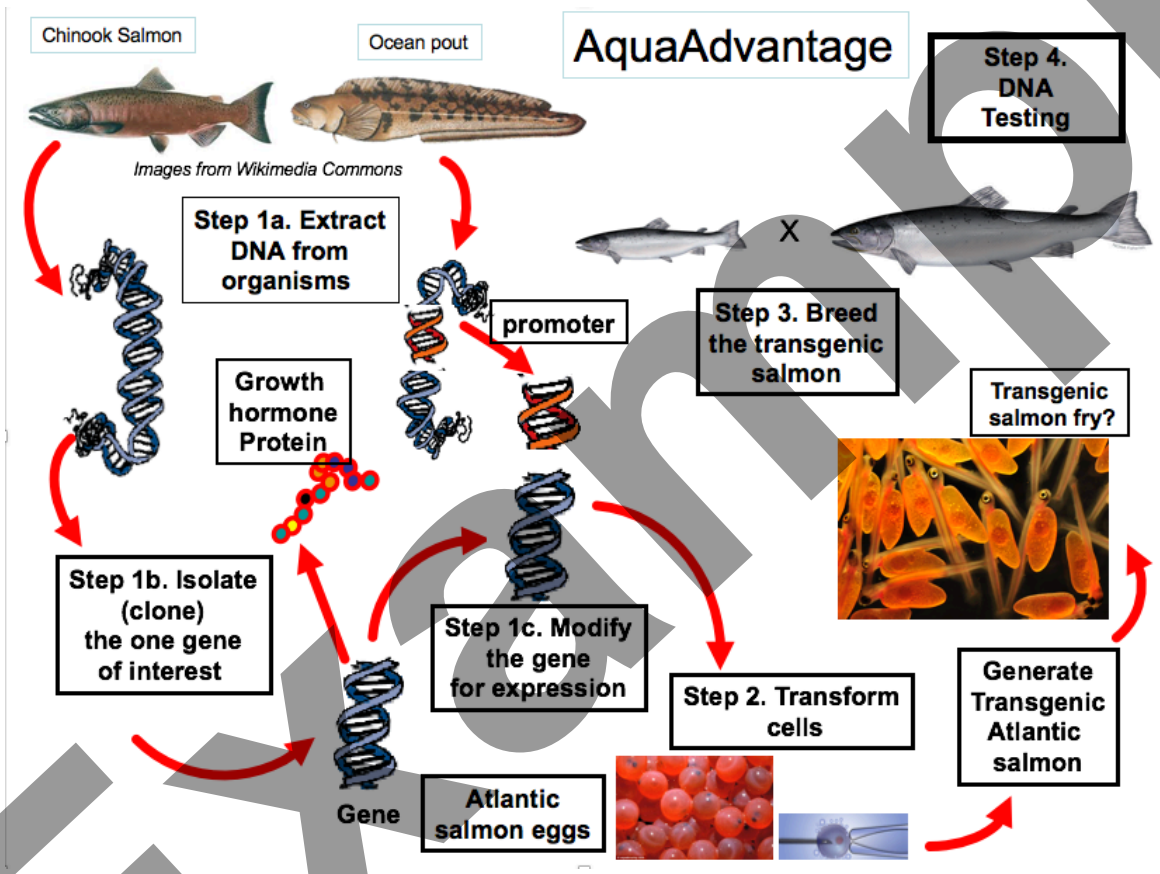
5. 50 pts: Scientific and non-scientific issues
   - Describe at least one science issue such as: can these transgenic Salmon escape and breed with wild Salmon?
   - Describe at least one non-science issue such as: will the public accept transgenic salmon in their diet?

6. 40 pts: Team produced a clear, organized and visually attractive outline/poster

Practicum KEY – Genetic Engineering information

This is what the AquaBounty genetic engineers accomplished:

1. find organism with the growth-rate gene
2. obtain DNA from this organism (all of its genes)
3. isolate and copy the gene encoding growth-rate protein
4. modify this gene with a promoter from ocean pout
5. transform a salmon egg with the modified gene
6. generate Atlantic salmon fry
7. breeding to incorporate other desired traits (elite line traits)



Salmon Breeding Steps (3 breeding plan options)

In each option, the goal is to have: A__ H__ I__

so all of the salmon will be
- Fast growing: AA or Aa
- Disease resistant: HH or Hh
- High Omega-3's: II or Ii

Creating fry for the Fish Farmer to Grow

In Option 1, we work to:

Create this new breed: AAHHii

To cross with a current breed: aahhII

Step 1: AAhhii x aaHHii

Option 1

	A	A
a	Aa	Aa
a	Aa	Aa

	h	h
H	Hh	Hh
H	Hh	Hh

	i	i
i	ii	ii
i	ii	ii

OR

	Ahi
aHi	AaHhii

→ **AaHhii**

Step 2: AaHhii x AaHhii

Option 1

	A	a
A	AA	Aa
a	Aa	aa

	H	h
H	HH	Hh
h	Hh	hh

	i	i
i	ii	ii
i	ii	ii

= Select **AAHHii**

OR

Step 2: AaHhii x AaHhii

Select **AAHHii**

	AHi	Ahi	aHi	ahi
AHi	AAHHii	AAHhii	AaHHli	AaHhli
Ahi	AAHhii	AAhhii	AaHhii	Aahhii
aHi	AaHHii	AaHhii	aaHHii	aaHhii
ahi	AaHhii	Aahhii	aaHhii	aahhii

Step 3: AAHHii x aahhII

Option 1

	a	a
A	Aa	Aa
A	Aa	Aa

	h	h
H	Hh	Hh
H	Hh	Hh

	I	I
i	Ii	Ii
i	Ii	Ii

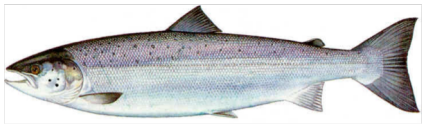
Select **AaHhIi**

	ahI
AHi	AaHhIi

In Option 2, we work to:

Use your transgenic as one breed

AAhhii



Cross with a new breed

aaHHII

Goal is to have: AaHhIi

Fry for the Fish Farmer to Grow

Step 1: aaHHii x aahhII

Option 2

	a	a
a	aa	aa
a	aa	aa

	h	h
H	Hh	Hh
H	Hh	Hh

	I	I
i	Ii	Ii
i	Ii	Ii

OR

	ahI
aHi	aaHhIi

aaHhIi

Option 2

Step 2: aaHhIi x aaHhIi

	a	a
a	aa	aa
a	aa	aa

	H	h
H	HH	Hh
h	Hh	hh

	I	i
I	II	Ii
i	Ii	ii

= Select **aaHHII**

OR

Step 2: aaHhIi x aaHhIi

	aHI	ahI	aHi	ahi
aHI	aaHHII	aaHhII	aaHHIi	aaHhIi
ahI	aaHhII	aahhII	aaHhIi	aahhIi
aHi	aaHHIi	aaHhIi	aaHHii	aaHhii
ahi	aaHhIi	aahhIi	aaHhii	aahhii

Select **aaHHII**

Option 2

Step 3: aaHHII x AAhhii

	A	A
a	Aa	Aa
a	Aa	Aa

	h	h
H	Hh	Hh
H	Hh	Hh

	i	i
I	Ii	Ii
I	Ii	Ii

= Select **AaHhIi**

OR

Step 3: aaHHII x AAhhii

	Ahi
aHI	AaHhIi

Select **AaHhIi**

In Option 3, we work to:

Create this new breed

AAhhII

Cross with a current breed

aaHHii

Fry for the Fish Farmer to Grow

Again, the goal is to have: AaHhIi

Step 1: AAhhii x aahhII

Option 3

	a	a
A	Aa	Aa
A	Aa	Aa

	h	h
h	hh	hh
h	hh	hh

	I	I
i	Ii	Ii
i	Ii	Ii

OR

	Ahi
ahI	Aahhli

Aahhli

Step 2: Aahhli x Aahhli

Option 3

	A	a
A	AA	Aa
a	Aa	aa

	h	h
h	hh	hh
h	hh	hh

	I	i
I	II	Ii
i	Ii	ii

= Select **AAhhII**

OR

Step 2: Aahhli x Aahhli

	AhI	Ahi	ahI	ahi
AhI	AAhhII	AAhhIi	AahhII	AahhIi
Ahi	AAhhIi	AAhhii	AahhIi	Aahhii
ahI	AahhII	AahhIi	aahhII	aahhIi
ahi	AahhIi	Aahhii	aahhIi	aahhii

Select **AAhhII**

Step 3: AAhhII x aaHHii

Option 3

	a	a
A	Aa	Aa
A	Aa	Aa

	H	H
h	Hh	Hh
h	Hh	Hh

	i	i
I	Ii	Ii
I	Ii	Ii

= Select **AaHhIi**

	aHi
AhI	AaHhIi