FUTURA
FOOD ENGINEERING

Metabolism Engineering Internship:

Health Bars for Disaster Relief

Engineering Notebook with Article Compilation

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Developed by the Learning Design Group at the University of California, Berkeley's Lawrence Hall of Science.

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Metabolism Engineering Internship:

Health Bars for Disaster Relief

Engineering Notebook

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Name: _____ Date: _____

Metabolism Engineering Internship: Health Bars for Disaster Relief

Unit Overview

As a food engineer intern, your job is to create a health bar that will be used during natural disasters to meet the metabolic needs of different groups of people—patients and rescue workers. You will design and test possible recipes using a digital model called the RecipeTest Design Tool. In addition to providing the best balance of nutrients to help people keep their energy up and heal their bodies, the health bars must taste good and not be too expensive.

Safety Guidelines for Science Investigations

Workplace safety is always a concern, especially in the labs here at Futura. Please review and follow these safety guidelines. If you have any questions, ask your internship coordinator for assistance.

1. **Follow instructions and listen carefully.** If you don't know what to do, ask your internship coordinator.
2. **Don't taste things.** No tasting anything or putting it near your mouth unless your internship coordinator says it is safe.
3. **Smell substances like a chemist.** When you smell a substance, don't put your nose near it. Instead, gently move the air from above the substance to your nose. This is how chemists smell substances.
4. **Protect your eyes.** Wear safety goggles if something wet could splash into your eyes, if powder or dust might get in your eyes, or if something sharp could fly into your eyes.
5. **Protect your hands.** Wear gloves if you are working with materials or chemicals that could irritate your skin.
6. **Keep your hands away from your face.** Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
7. **Tell your internship coordinator if you have allergies.** We want you to be safe and comfortable at work.
8. **Be calm and careful.** Move carefully and slowly around the office and labs.
9. **Report all spills, accidents, and injuries to your internship coordinator.**
10. **Avoid anything that could cause a burn.** Ask your internship coordinator for help with hot water or hot equipment.
11. **Wash your hands with soap and water at the end of the workday, especially if you've handled plants, animals, or chemicals.**

Amina Reid, Project Director
Futura | Food Engineering Division

Safety Agreement

By writing my name below, I agree to follow the rules outlined in the Safety Guidelines while working at Futura.

_____

Name: _____ Date: _____

Day 1: Welcome!

Hello interns,

I am excited for you to join this new food engineering internship at Futura! I love working for our company because we work to solve problems that affect people around the planet.

We will be working on a project for International Disaster Aid (IDA) to design health bars that both rescue workers and patients can eat to keep their energy up and meet the needs of their bodies during disaster relief efforts.

There are three things to consider when planning a health bar design:

1. Meeting the metabolic needs of rescue workers and patients.

2. Having a high taste score, so that people will want to eat the bars.

3. Keeping the cost low so that IDA can help as many people as possible.

We'll get started by learning more about metabolism. Today, your internship coordinator will introduce you to the project resources: the RecipeTest Design Tool and the Futura Food Engineer's Dossier. Note: *Dossier* (DAW-see-ay) is a term professionals sometimes use for a set of related documents. It includes a glossary to support you if you need help with unfamiliar words.

Deliverables:

- Annotations for Chapter 2: "Meeting Your Metabolic Needs"
- After Hours: Annotations for Chapter 1: "Request for Proposals"

Good Luck!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Name: _____ Date: _____

After-Hours Work

Return to the Day 1: Welcome! message from Amina Reid on page 3 and be sure you've completed all internship tasks for the day.

- Read and annotate Chapter 1 in the Dossier: "Request for Proposals" (RFP). Your internship coordinator may have asked you to complete additional tasks.
- If you are required to read the Safety Guidelines and read and complete the Safety Agreement form, find those on page 2 of your Engineering Notebook.
- Double-check your Daily Message to see if there are other deliverables that need to be completed after hours.

Name: _____ Date: _____

Day 2: Researching Ingredients

Welcome back, interns!

We will continue researching metabolism today. You will focus on making connections between metabolism and FuturaBar ingredients by researching and making predictions about how various ingredients are metabolized and meet people's specific needs, including your own.

By understanding the relationship between nutrients and metabolic function, you'll be able to design a better FuturaBar that helps many different kinds of people function in disaster areas. While you are working today, think about how specific nutrients on the small scale (cellular level) affect your body's ability to grow, breathe, think and move. You'll need to figure this out before you can start designing your FuturaBar. After hours, please reread Chapters 2–3 of the Dossier and add to or revise your annotations.

Deliverables:

- Researching Ingredients sheet
- After Hours: Reread Chapters 2 and 3, and revise annotations for Chapter 2, thinking about how different nutrients affect your metabolic needs
- Complete any additional tasks your internship coordinator has asked you to do

Hope you learn a lot today!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

Researching Ingredients

1. Choose a food from the Ingredients Table in Dossier Chapter 3. Each member of your design team should choose a different ingredient.

2. Use the information in Chapters 2 and 3 in the Dossier and the diagram below to gather information about your ingredient.

3. Complete questions in Part 1.

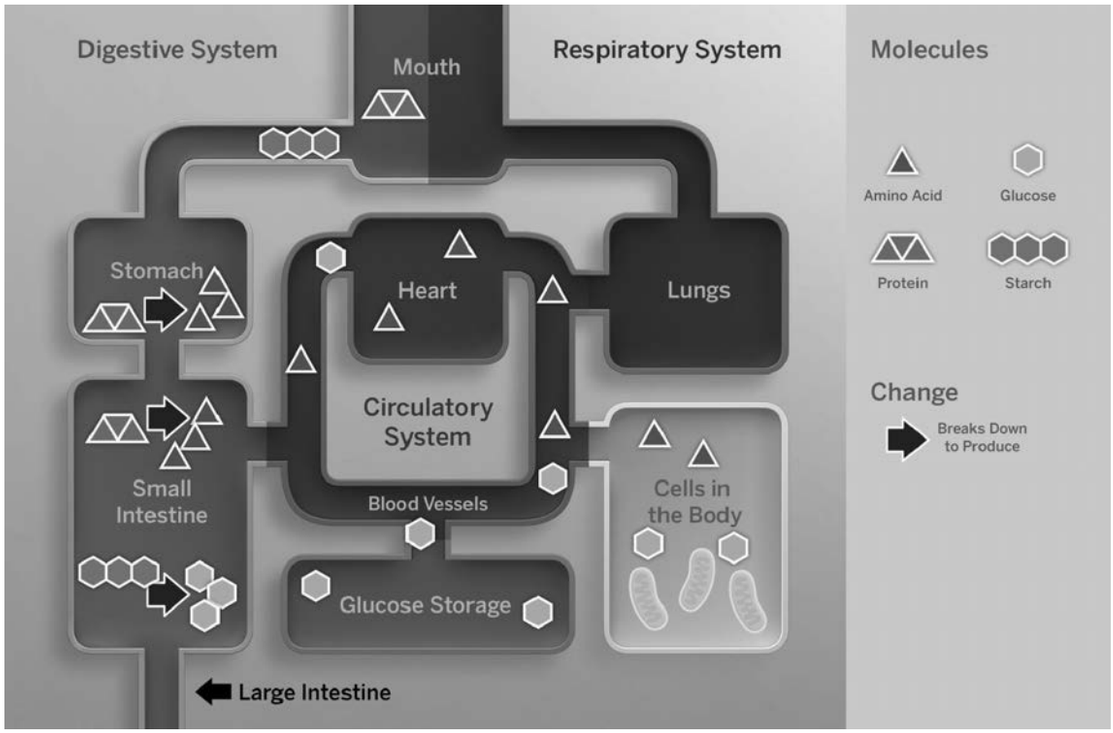
4. Share information about your ingredient with the other members of your group.

5. Discuss and complete the questions in Part 2 with your group members.

Part 1

Record the following information about your ingredient:

- Carbohydrate content: _____
- Protein content: _____
- Glycemic index: _____



Name: _____ Date: _____

Researching Ingredients (continued)

What happens in your body after you eat the ingredient you investigated?

_____

_____

_____

What important molecules does your ingredient provide to your cells? Why do your cells need those molecules?

_____

_____

_____

Part 2

Choose an ingredient that one of your group members researched. What happens in your body after you eat that ingredient? How is it similar to or different from the ingredient you researched?

_____

_____

_____

Look back at the Ingredients Table in the Dossier. If you could only eat one food on the ingredient list all day for one week, which one would you choose and why?

_____

_____

_____

Name: _____ Date: _____

After-Hours Work

Return to the Day 2: Researching Ingredients message from Amina Reid on page 5 and be sure you've completed all internship tasks for the day.

- Reread and annotate Chapter 2: "Meeting Your Metabolic Needs" and Chapter 3: "Ingredient Information" in the Dossier: "Request for Proposals" (RFP).
- Add to or revise your annotations using this focus question: *How do different nutrients help people meet different metabolic needs?*
- Your internship coordinator may have asked you to complete additional tasks.
- Double-check your Daily Message to see if there are other deliverables that need to be completed after hours.

Name: _____ Date: _____

Day 3: Target Populations

Hi interns,

Today you'll continue your research by learning more about the different target populations that you'll be designing recipes for. IDA is looking for designs that will meet the needs of their rescue workers and the patients that they serve. Different people have different metabolic needs, so you'll want to choose your ingredients carefully.

It is really important that you make sure you understand the metabolic needs of these target populations before you begin testing out different recipe designs. Luckily, Futura found some volunteer test users to serve as representatives of each target population to help us out. Today, you and your group will analyze the needs of the test users using the Dossier Chapter 4: "Target Populations."

Deliverables:

- Annotations for Ch. 4: "Target Populations"
- Test Users' Notes in Futura Workspace

Good luck with your research!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

After-Hours Work

Return to the Day 3: Target Populations message from Amina Reid on page 9 and be sure you've completed all internship tasks for the day.

- Open the Dossier.
- Reread Chapter 4: "Target Populations".
- Add to or revise your annotations using these focus questions: *Why do some test users need high glycemic index foods, while others do not?*

Your internship coordinator may have asked you to complete additional tasks. Double-check your Daily Message Notes to see if there are other deliverables that need to be completed after hours.

Name: _____ Date: _____

Day 4: Analyzing Ingredients

Hi Interns,

I'm glad to see how quickly you are learning! Today you will finish up this phase by isolating variables, a process that will let you see how changing one ingredient at a time affects the RecipeTest results. You'll also begin to consider trade-offs. A trade-off is when you have to give up one thing in return for another.

Today you will use RecipeTest to complete your research by analyzing the health bar ingredients. You'll also set some priorities so that you are ready to begin designing your FuturaBar recipes during your next day at the office. After-hours, I want you to show your understanding of the project so far by completing the Project Summary form.

Deliverables:

- Health Bar Ingredients Analysis
- After-Hours: Project Summary

Good luck today!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

Ingredients Analysis

1. In your group, decide which four ingredients each pair of students will test. Circle each ingredient that you and your partner are responsible for investigating.

2. In your pair, decide which partner will test for Rescue Workers and which partner will test for Patients.

3. Test 1 ingredient at a time by selecting 100 grams of the same ingredient and click SEND TO LAB.

4. Compare the results with your partner to see how the target populations are similar or different.

5. In the table below, record notes on the results for each criterion for both target populations.

6. Share your findings with your group members, and answer the questions that follow.

Name: _____ Date: _____

Type	Metabolic Needs Patients	Metabolic Needs Rescue Workers	Taste Score	Cost per Bar
Raisins	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			
Pumpkin Seeds	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			
Nonfat Milk Powder	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			
Puffed Wheat	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			

Name: _____ Date: _____

Type	Metabolic Needs Patients	Metabolic Needs Rescue Workers	Taste Score	Cost per Bar
Puffed Rice	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			
Soy Beans	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			
Nutritional Yeast	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			
Chocolate Chips	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			

Name: _____ Date: _____

Type	Metabolic Needs Patients	Metabolic Needs Rescue Workers	Taste Score	Cost per Bar
Prunes	Notes on Growth & Repair and Energy needs:	Notes on Growth & Repair and Energy needs:		
	Notes on Patients vs. Rescue Workers:			

Name: _____ Date: _____

Ingredients Analysis (continued)

Based on your research:

1. Which ingredients do you think will make the best tasting bar? Why?

_____

_____

_____

2. Which ingredients do you think would produce the best bar for meeting growth and repair needs? Why?

_____

_____

_____

3. Which ingredients do you think would produce the best bar for getting an immediate burst of energy? Why?

_____

_____

_____

4. Which ingredients do you think would produce the best bar for storing energy to use later?

_____

_____

_____

Name: _____ Date: _____

Ingredients Analysis (continued)

5. Which ingredients do you think will be best for keeping the cost of the bar low?

_____

_____

_____

Name: _____ Date: _____

After-Hours Work

Return to the Day 4: Analyzing Ingredients message from Amina Reid on page 11 and be sure you've completed all internship tasks for the day.

- Complete the Project Summary form on the next page. If needed, refer back to the RFP in the Dossier to review the project details.

Your internship coordinator may have asked you to complete additional tasks. Double check your Daily Message and Daily Message Notes to see if there are other deliverables that need to be completed after hours.

Name: _____ Date: _____

Project Summary

Defining the Problem: Summarize your understanding of the project by answering the following questions. You may wish to review the Dossier to help you respond to the questions.

1. What is the engineering problem you are trying to solve during this project?

_____

_____

_____

2. Describe the first criterion: meet the metabolic needs of the target population. Why is it important?

_____

_____

_____

3. Describe the second criterion: have a high taste score. Why is it important?

_____

_____

_____

4. Describe the third criterion: keep costs low. Why is it important?

_____

_____

_____

5. Based on your research so far, which criterion do you think is most important for a successful health bar design? Why?

_____

_____

_____

Name: _____ Date: _____

Day 5: Designing FuturaBars

Hello interns!

Today you begin the Design phase of the internship. Think about what you've learned from reading the Dossier during the Research phase: nutrients that come from the foods we eat are composed of mostly protein and carbohydrates. Our bodies metabolize these into amino acids for cellular growth and repair and glucose for energy. Some carbohydrates break down quickly which results in immediate energy. Carbohydrates that break down more slowly are good for long term energy release. You will use RecipeTest to build health bars that meet the metabolic needs of the target populations, taste good, and are affordable so that more people will have access to them.

You'll run many iterative tests to find an effective design. Each time you test a FuturaBar design, you will analyze the results to see how you can improve your next version. When engineers test designs, they use the results to help plan the next design.

Before you leave today, your team should send me the results of the design you like best. I'll review it and send you feedback about how well your design addresses the project criteria.

Deliverables:

- Several designs recorded on RecipeTest Data
- RecipeTest Design form

Cheers,

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

RecipeTest Design

Target Population: Patients / Rescue Workers (circle one)

Record your optimized recipe and testing data here. Then you will submit your optimized recipe in the RecipeTest Design Form in Futura Workspace in order to receive feedback from the project director.
Note: Only one partner needs to submit a form for feedback.

Version: _____

1. How many grams of raisins? _____
2. How many grams of pumpkin seeds? _____
3. How many grams of nonfat milk powder? _____
4. How many grams of puffed wheat? _____
5. How many grams of puffed rice? _____
6. How many grams of soy beans? _____
7. How many grams of nutritional yeast? _____
8. How many grams of dark chocolate chips? _____
9. How many grams of prunes? _____
10. What is your FuturaBar's taste score? _____
11. What is the total cost for one of your FuturaBars? _____
12. What percent (%) of your FuturaBar is protein? _____
13. What percent (%) of your FuturaBar is carbohydrates? _____
14. What is your FuturaBar's glycemic index? _____

Name: _____ Date: _____

Day 6: Choosing an Optimal Design

Hi Interns,

I reviewed the results for the design your team submitted and sent a feedback letter. Work with your colleagues and internship coordinator to review and interpret my comments. Then, think about my suggestions as you do more iterative testing and choose an optimal recipe. It may be helpful to revisit the Dossier as you plan your final designs. After hours, I want to know your thoughts about the trade-offs of your optimal design.

You've probably noticed that each version you've designed has trade-offs—when a design can be strong for one criterion, but not as good for another. To identify an optimal solution to a problem, engineers share and discuss results, consider trade-offs, and set priorities in order to improve their designs.

Deliverables

- Design Feedback Summary
- Record several new designs
- Optimal design selected
- After-hours: Trade-Offs Reflection

Many thanks!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

Design Feedback Summary

Submitted Version	Protein Content (Criterion: Meet metabolic needs)	Carbohydrate Content (Criterion: Meet metabolic needs)	Glycemic Index (Criterion: Meet metabolic needs)	Criterion: Taste Score	Criterion: Cost per Bar
Design details					
Feedback from project director					
Goal for meeting criterion					
Redesign strategy					

Name: _____ Date: _____

After-Hours Work

Return to the Day 6: Choosing an Optimal Design message from Amina Reid on page 22 and be sure you've completed all internship tasks for the day.

- Complete the Trade-Offs Reflection form on the next page.

Your internship coordinator may have asked you to complete additional tasks. Double-check your Daily Message and Daily Message Notes to see if there are other deliverables that need to be completed after hours.

Name: _____ Date: _____

Trade-off Reflection

A *trade-off* happens in a situation where a design has good results for one criterion but not for another. Look at the results for your optimal FuturaBar design. Describe some of the trade-offs you noticed while designing your FuturaBar.

1. Which criterion did you prioritize? (check one)

   ☐ metabolic needs of target populations met

   ☐ high taste score

   ☐ keep cost low per bar

2. Why did you prioritize this criterion?

_____

_____

_____

_____

_____

3. When you prioritized this criterion, what were some of the trade-offs? Describe what happened to the results of the other two criteria.

_____

_____

_____

_____

_____

Name: _____ Date: _____

Day 7: Composing Proposal Outlines

Hello interns,

Today you will start working on your design proposal. Proposals are one way scientists and engineers communicate their ideas. You will use the proposal to explain why you think your chosen design is optimal. Writing good proposals can be hard, so I've asked your internship coordinator to help you outline the most important section, the Design Decisions. You might also want to refer to the Dossier for information and resources to help you.

Engineering proposals explain how a design addresses each of the project criteria. If you include strong evidence in your argument that demonstrates you understand how and why your design works, it is more likely that your proposal will be considered by International Disaster Aid. The outline process will help you collect and organize evidence that supports the argument that you have selected an optimal design. I will review the Background Research sections of your outline and send feedback to help improve your final proposals. I always appreciate feedback when I am working on a formal proposal.

Deliverables:

- Proposal Outline

Use lots of evidence!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

Proposal Outline

Instructions

For each criterion, list the pieces of evidence from your iterative testing, Ingredients Analysis, Design Feedback Summary, and Dossier research that support your optimal design.

Optimal Design

Target Population: ☐ Rescue Workers ☐ Patients

List the design details of your proposed optimal design.
Version #: _____ List ingredients used:_____

Metabolic Details: ☐ % Protein ☐ % Carbohydrates ☐ Glycemic Index

Design Decisions

For each criterion, list the pieces of evidence from your iterative testing, Ingredients Analysis, Design Feedback Summary, and Dossier research that support your optimal design.

Metabolic Needs

DATA ANALYSIS

Nutrient Details: Protein Content(%)	Design goal:
Nutrient Details: Carbohydrate Content(%)	**Design goal:**
Nutrient Details: Glycemic Index	**Design goal:**

Comparison to another design:

BACKGROUND RESEARCH

Think about how your design choices affected metabolic needs. How did the glycemic index and the amount of carbohydrates and proteins in your recipe affect the results for growth and repair and energy needs? What information about these nutrients applies specifically to the metabolic needs of your target population? Why did you choose specific ingredients to meet specific metabolic needs?

Name: _____ Date: _____

Proposal Outline (continued)

Taste

DATA ANALYSIS

Final result:

Design goal:

Comparison to another design:

BACKGROUND RESEARCH

Think about how your design choices affected taste. What information about the ingredients is related to the taste score?

Cost

DATA ANALYSIS

Final result ($):

Design goal ($):

Comparison to another design:

BACKGROUND RESEARCH

Think about how your design choices affected the cost of the FuturaBar. What information about the ingredients is related to the cost?

Name: _____ Date: _____

Day 8: Writing Design Decisions

Greetings interns,

Today you will use my feedback on your proposal outlines to write the Design Decisions paragraphs of your proposal. These paragraphs are the heart of your argument that explains why your health bar design is an optimal one. You might also want to refer to the Dossier for information and resources to help you write.

Writing strong proposals for a specific audience, helping them understand the project and your decisions, is an important part of being an engineer. You know more about the science behind your design than most of the people who will be reading your proposal, so your writing should be clear and professional. Writing clear arguments that explain your thinking is an essential part of scientific communication.

Deliverables:

- Final Proposal: Design Decision paragraphs

Happy writing!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

Tips: Help With Your Proposal

Interns,

If you need some help getting started with your paragraphs, here are some ideas to choose from.

DESIGN DECISIONS PARAGRAPHS

About specific criteria:

- For our proposed design, the results for metabolic needs (growth and repair and energy) were . . .
- We were able to meet the metabolic needs of our target population by . . .
- We were able to keep costs low by . . .
- Using the Futura RecipeTest Design Tool, we picked a design that . . .

When talking about your goals:

- Our goal was . . .
- Based on design feedback, we chose to set a goal to . . .

For comparing designs:

- In another design, we got _____ but . . .

For talking about background research:

- Background research told us that . . .
- In the Dossier, we learned that . . .
- Research with RecipeTest showed us that . . .

Name: _____ Date: _____

Tips: Help With Your Proposal (continued)

INTRODUCTION

- This FuturaBar design used (list ingredient types). This recipe had (list metabolic information like % carbohydrate, % protein, glycemic index).
- The results showed the design met _____% of the metabolic needs for growth and repair.
- The results showed the design met _____% of the metabolic needs for short term energy and _____% of the metabolic needs for long term energy.
- This design had a taste score of _____.
- The cost per bar was _____.

CONCLUSIONS

- Our FuturaBar design is the optimal choice because . . .
- Our priority was the criterion _____ because . . .
- Our FuturaBar design will meet the needs of International Disaster Aid because . . .
- Even though our recipe does not _____, we think it is optimal because . . .
- This FuturaBar recipe will (write something about one criterion here) well because . . .
- A trade-off we had to make in our optimal design was . . .

Hope this helps!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Name: _____ Date: _____

Final Proposal

When writing your Final Proposal, remember to write in a clear and professional manner. Refer to these resources:

- Proposal Rubric and Sample Proposal
- RecipeTest Data
- Background research and notes
- Food Engineer's Dossier
- Proposal Outline feedback letter

Introduction

Use your responses from the Project Summary to describe the project goal and criteria. Add one to two sentences to describe your optimal design.

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Name: _____ Date: _____

Final Proposal (continued)

Design Decisions

Use your Proposal Outline and feedback from your project director to explain how your design addresses each criterion.

Metabolic Needs

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Taste

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Name: _____ Date: _____

Final Proposal (continued)

Cost Per Bar

Conclusion: Considering Trade-Offs

Use your responses from the Trade-Offs Reflection to describe your design priorities and the resulting trade-offs. Add your closing statement.

Name: _____ Date: _____

Day 9: Completing the Proposal

Hello interns,

Today you'll be focusing on finishing your proposal by adding two more paragraphs: the beginning and the ending! Your internship coordinator will help you use the Project Summary to write the Introduction, and the Trade-Offs Reflection to write the Conclusion. You might also want to refer to the Dossier for information and resources to help you write.

These two paragraphs are the final sections of your proposal. The introduction explains the project to the reader, while the conclusion shows that you've thought carefully about the trade-offs involved in your optimal health bar design. Remember to use scientific and professional language to communicate your ideas.

You might notice that writing this proposal is like iterative testing—you are taking a version, analyzing and revising it, and then rewriting to improve the final version!

Deliverables:

- Completed Final Proposal

I look forward to reading your excellent proposals!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

Day 10: Thanks, Interns!

Dear interns,

Today is the final day of your internship with me here at Futura's Food Engineering Division. I'm impressed with the variety of health bars you've designed.

I really enjoyed watching you learn how to think critically about various metabolic needs, nutrients, and design criteria, while practicing good scientific communication with your colleagues. I hope that you will be able to take some of what you have learned here and apply it to help you with future problem solving and scientific arguments. You've been great interns!

There is one last task that I have for you: an Internship Exit Survey. Please get started on it now—your responses will help us improve internships for the next batch of interns!

Deliverables:

- Internship Exit Survey

Good luck in the future!

Amina

Amina Reid, Project Director
Futura | Food Engineering Division

Daily Message Notes

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Name: _____ Date: _____

Internship Exit Survey

Futura would like to improve the internship experience for future interns. Please complete this survey to give us feedback.

How comfortable would you feel explaining the following concepts to a new intern?

1. How a student's job is different from an intern's job. (check one)

- ☐ Very uncomfortable. I don't understand this.
- ☐ Uncomfortable. I'm not sure I understand this.
- ☐ Pretty comfortable. I think I understand this.
- ☐ Very comfortable. I totally understand this.

2. What criteria are and how they are related to designing something. (check one)

- ☐ Very uncomfortable. I don't understand this.
- ☐ Uncomfortable. I'm not sure I understand this.
- ☐ Pretty comfortable. I think I understand this.
- ☐ Very comfortable. I totally understand this.

3. What a trade-off is and how a trade-off affects engineering designs. (check one)

- ☐ Very uncomfortable. I don't understand this.
- ☐ Uncomfortable. I'm not sure I understand this.
- ☐ Pretty comfortable. I think I understand this.
- ☐ Very comfortable. I totally understand this.

4. Why scientific communication is important in engineering. (check one)

- ☐ Very uncomfortable. I don't understand this.
- ☐ Uncomfortable. I'm not sure I understand this.
- ☐ Pretty comfortable. I think I understand this.
- ☐ Very comfortable. I totally understand this.

Name: _____ Date: _____

Internship Exit Survey (continued)

Imagine you are giving advice to a new Futura Engineering intern.

5. Imagine you are giving advice to a new Futura Engineering intern. What would you tell them about the engineering design process?

_____

_____

_____

6. What was hard or challenging about the internship?

_____

_____

_____

7. What tips would you suggest for a successful internship?

_____

_____

_____

Metabolism Engineering Internship Glossary

analyze: to examine in detail for a purpose

analizar: examinar en detalle y con un propósito

carbohydrate: a group of molecule types that are broken down by the digestive system into glucose

carbohidrato: un grupo de tipos de moléculas que son descompuestos en glucosa por el sistema digestivo

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ingeniero/a en alimentos: un tipo de ingeniero/a que resuelve problemas relacionados con los materiales, la seguridad, el almacenamiento, y la distribución de los alimentos

glucose: a molecule that organisms can use to release energy, and that is made of carbon, hydrogen, and oxygen atoms

glucosa: una molécula que los organismos pueden usar para liberar energía y que está hecha de átomos de carbono, hidrógeno y oxígeno

Metabolism Engineering Internship Glossary (continued)

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necesidades metabólicas: lo que el cuerpo necesita para desempeñar procesos celulares para el crecimiento y la reparación y la liberación de energía

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variable: something that can be changed and may be measured

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Metabolism Engineering Internship:

Health Bars for Disaster Relief

Article Compilation

FUTURA FOOD ENGINEER'S DOSSIER

FUTURA
FOOD ENGINEERING

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Chapter 1:

Request for Proposals (RFP)

International Disaster Aid (IDA) is a large nonprofit organization providing relief and medical services to areas affected by natural disasters, such as forest fires, floods, hurricanes, earthquakes, and tornadoes. IDA provides medical care for the sick and wounded and has a team of trained rescue workers who search for and provide help to individuals who are still in danger.

IDA would like to provide its staff and patients with health bars to help them meet their nutritional needs during a natural disaster. Rescue workers are active and need to keep their energy up while they are providing disaster relief, while people with injuries need extra energy and protein to help their body recover. IDA seeks proposals for a health bar to feed the rescue workers and patients at disaster sites. Health bars can be packed with nutrients, carried easily, and eaten quickly, making them ideal for disaster sites. Futura Engineering's Nutrition Division will focus on designing a recipe for a health bar that will help IDA meet its goal.

Aid organizations like International Disaster Aid give food, medical supplies, and other useful things to people who have been affected by disasters. This rescue worker is giving out bags of everyday items people might need.

Successful proposals will address three criteria:

1. Meet the metabolic needs of the target population

Patients and rescue workers in disaster locations need nutrients to help them keep their energy up and heal their bodies. Different populations have specific needs, and successful health bars must meet those needs.

2. Have a high taste score

A health bar that tastes terrible will most likely go to waste; the bars need to taste good so people will be willing to eat them. The taste score is a measure of how highly people rate the bars' taste.

3. Keep costs low

International Disaster Aid's funds are limited since the money comes from donations. The organization has a strict budget, so the less they spend on each bar, the more people they can serve.

Aid workers load boxes of supplies onto a truck that will take them where they're needed.

Chapter 2:

Meeting Your Metabolic Needs

The food you eat is mostly made of nutrients like proteins and carbohydrates. Along with oxygen, carbon dioxide, and water, these foods play an essential role in human metabolism. That is the process in which your body uses molecules like glucose and amino acids for energy and growth. On a small scale (molecular level), when your metabolic needs are met, it means that your body has everything it needs in order to grow and repair your cells, as well as release energy from glucose through the process of cellular respiration. On a large scale (whole body level), it means that your body has everything it needs to perform required activities like breathing, thinking, and moving. Different people have different metabolic needs depending on their health, activity level, and age.

Health bars may contain many different combinations of ingredients to meet the needs of many different people.

Growth and Repair Needs

Your body is constantly repairing and replacing old and damaged cells and tissues, a process which requires both energy and protein. Bodies that are stressed, either by injury or strenuous activity, are especially occupied with the growth and repair process. When we take in proteins through the foods we eat, our bodies break down the proteins into amino acid molecules. Then our bodies chemically rearrange the amino acids to form specific molecules needed by the cells and tissues for growth and repair.

Energy Needs

Your body uses carbohydrates like starch to release energy that it needs to move, think, stay warm, and grow. The digestive system breaks down starch into glucose. During cellular respiration, glucose and oxygen molecules are chemically rearranged to form carbon dioxide and water molecules, releasing energy in the process.

Carbohydrates break down at different rates, and the rate of metabolism affects how the body functions. Glycemic index is a measure of how quickly carbohydrates break down into glucose. (The word *glycemic* refers to glucose.) Carbohydrates that break down slowly, such as the carbohydrates found in broccoli, have a low glycemic index. Foods with a lower glycemic index are better for providing energy that lasts over a longer period of time. Some carbohydrates that break down quickly, such as the carbohydrates found in watermelon, have a high glycemic index. Foods with a higher glycemic index are better for providing energy that is available almost immediately.

Chapter 3:

Ingredient Information

raisins

pumpkin seeds

nonfat milk powder

puffed wheat

puffed rice

soy beans

nutritional yeast

dark chocolate chips

prunes

Several different ingredients are available for your health bar recipes.

Ingredients Table

Ingredient	Protein Content	Carbohydrate Content	Glycemic Index
raisins	low	high	high
pumpkin seeds	high	low	medium
nonfat milk powder	medium	medium	medium
puffed wheat	low	high	high
puffed rice	low	high	high
soy beans	medium	medium	low
nutritional yeast	high	low	low
dark chocolate chips	low	high	low
prunes	low	high	low

The information listed above is based on the following value ranges:

Protein (%): low= 0-33, medium= 34-66, high= 67-100.
Carbohydrate (%): low= 0-33, medium= 34-66, high= 67-100.
Glycemic Index: low= 0-30, medium= 31-60, high= 61-80.

Chapter 4:

Target Populations

International Disaster Aid (IDA) has identified two groups of people who could benefit from health bars. These are referred to as the "target populations." Within each target population, several people have volunteered to test out FuturaBars to see how each bar meets their needs. These people are referred to as "test users," and they are examples of the kinds of people in the target populations. Below is more information on each target population and its volunteer test users.

Target Population: Patients

After severe natural disasters, hospitals are often filled with patients who have varying needs. Some are in critical condition, while others are less severely wounded. All patients need high levels of protein for the growth and repair processes, such as healing broken bones or recovering from brain injuries. Without high levels of protein, their injuries will not heal properly or quickly. In addition to protein, these growth and repair processes require energy. To help themselves recover, some patients must also exercise, which requires additional energy. These patients need carbohydrates to give them energy. Overall, patients need a constant supply of energy that is not released too quickly or too slowly.

PATIENT 1

These test users have improved so much, they are almost ready to go home. They can be active, so they exercise often in order to rebuild their muscles.

PATIENT 2

These test users have injuries that are not too bad. Some are rescuers who were injured while working. They are able to exercise while their bodies repair themselves.

PATIENT 3

These test users have serious injuries. They mostly stay in bed and can only get up for short periods of light exercise. Their bodies need energy for growth and repair.

PATIENT 4

These test users have life-threatening injuries. They must stay in bed and can only move a little. Their bodies are doing growth and repair on a large scale.

Target Population: Rescue Workers

The rescue effort to find people and move fallen buildings and debris is intense. Rescue workers often work all day, climbing through brush or damaged buildings, carrying victims to safety, and providing medical attention. The workers are healthy people who have high energy needs throughout the day. They do many activities that require them to use energy immediately, but they also need sustained energy in order to work for long periods. In addition to carbohydrates, rescue workers must have protein to repair tired muscles at the end of the day or minor injuries that they receive.

RESCUE WORKER 1

These test users go out and search for injured people. They travel long distances, often for long periods of time, so they need a source of energy that lasts.

RESCUE WORKER 2

These test users need energy right away as they hurry to help injured people. They may need to move rocks or parts of fallen buildings and sprint, dig, or swim.

RESCUE WORKER 3

These test users are teenagers. This is difficult work, and since their bodies are still growing, they need molecules that will help them grow AND repair.

RESCUE WORKER 4

Elite test users do it all. Their days are long and their work is intense, so they need energy that lasts. They also need to move fast when people are trapped and need help immediately.

Chapter 5:

Proposal Resources

Sample Proposal: Designing a Greener Toothbrush

INTRODUCTION

Our team at Futura Engineering is working for Dentists for the Planet to design a better toothbrush that isn't bad for the Earth but is also good for people's teeth. The toothbrush should have a low environmental impact so it doesn't make trash or pollution when you're done with it. Designs should have a high clean-mouth rating because that means the toothbrush removes as much tooth plaque as possible. And the toothbrush should be low-cost so more people can buy the toothbrush and help the planet. Our optimal design uses a plant-based plastic handle and natural-fiber bristles. This toothbrush design has a medium environmental impact rating of 3.1, a clean-mouth rating of 84%, and costs $2.08 per toothbrush.

Not all toothbrushes are the same. They come in different styles and have different strengths and weaknesses.

DESIGN DECISIONS

Environmental impact: The proposed toothbrush design has an environmental impact rating of 3.1. Based on design feedback, we set a goal of an environmental impact rating of 3.5 or lower. We had another design with a lower impact rating of 1.9 with bamboo handle and natural-fiber bristles, but it didn't do well for other criteria. The handle we chose is made of a plastic that comes from plants and is meant to be recycled, and can slowly biodegrade, which means it is better for the environment. The bristles are natural fibers and are completely biodegradable. These materials are made from trees, which can break down in a compost or landfill without producing pollution.

Keeping mouths clean: Our design has a clean-mouth rating of 84%, which is better than our goal of 80%. We found that plastic bristles and natural-fiber bristles both removed at least 80% of

Image credit: Shutterstock

plaque, and the more plaque removed, the less tooth decay there is, and the healthier people are. Therefore, we selected the natural-fiber bristles for our design. We had a cheaper design using nylon bristles ($1.20 per toothbrush), but the clean-mouth rating for that toothbrush was only 53%. The plant-based plastic handle also affected the clean-mouth rating because the strength of the handle affects how much plaque is removed. Plastics are stiffer and help the person remove more plaque while brushing compared to more flexible handles made from all plant material.

Toothbrushes can be made from many different materials.

Cost: Our proposed design costs $2.08 per toothbrush. Our team tried to make a toothbrush that cost around $1.90 based on our team goal. We had a plan that cost only $1.20, but it had a high environmental impact and a very low clean-mouth rating. Plastic handles cost the least and plant-based plastic handles cost more but are still less expensive than all bamboo handles. Natural-fiber bristles cost more than nylon or plastic bristles. Since we didn't use the most expensive handles, our cost is still in an affordable range.

CONCLUSION: CONSIDERING TRADE-OFFS

We learned that toothbrush materials that work the best at cleaning the mouth are expensive and are not good for the environment. Toothbrush materials that are best for the environment don't do well at cleaning teeth and can also cost more. The cheapest handles were the worst for the environment but good at cleaning the mouth. The cheapest bristles were okay for the environment but not very good at cleaning the mouth. We focused on the criterion we think is most important: keeping mouths clean. Because we focused on the clean-mouth rating, the toothbrush costs more than other designs. Our proposed design is optimal because, even though it doesn't have the best environmental impact or cost, it is excellent at getting rid of tooth plaque which is important for keeping mouths, and people, healthy.

Proposal Rubric

INTRODUCTION

Needs Improvement	Developing	Proficient	Excels
Introduction is incomplete; missing one or more criteria and no mention of the proposed design	Lists the criteria of the project but does not describe them; mentions the proposed design by listing the results or details but not both	Summarizes the design request and describes most criteria; describes the proposed design by listing the results or details but not both	Thoroughly summarizes the design request and describes the proposed design by listing the variables or details and the final results

DESIGN DECISIONS (same for each criterion)

Needs Improvement	Developing	Proficient	Excels
No evidence is provided to support the design decision; explanation is inadequate or missing	Uses minimal evidence to support the design decision and does not explain why the specific feature was selected over other options and/or how that feature of the design relates to the criterion	Uses some evidence to support design decision, mostly explaining why the specific feature was selected over other options and how that feature of the design relates to the criterion	Uses multiple pieces of strong evidence to support design decision, thoroughly explaining why the specific feature was selected over other options and how that feature of the design relates to the criterion

CONCLUSION: CONSIDERING TRADE-OFFS

Needs Improvement	Developing	Proficient	Excels
Two or more of the following need attention: design priorities, summary of trade-offs in the optimal design, or a closing statement	One of the following needs attention: design priorities, summary of trade-offs in the optimal design, or a closing statement	Includes all of the following, but may lack detail: design priorities, summary of trade-offs in the optimal design, and a closing statement	Description of design priorities is clear; summary of trade-offs in the optimal design is detailed and thorough; includes a strong closing statement

SCIENTIFIC COMMUNICATION

Needs Improvement	Developing	Proficient	Excels
Lacks topic-specific vocabulary; uses informal style or language	Attempts to use topic-specific vocabulary and formal writing style, but needs improvement	Uses some topic-specific vocabulary; uses formal writing style somewhat successfully	Uses topic-specific vocabulary clearly and appropriately; uses formal writing style successfully

Chapter 6:

Engineering Glossary

analyze: to examine in detail for a purpose

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