Feeding Future Cities:

Select one vegetable and one protein and design a way to grow enough of each within your future city limits to feed your citizens.

Many thousands of years ago, humans learned to domesticate animals and grow plants for food. Because we no longer needed to hunt and gather, we could stay in one place and start to build cities. It was the beginning of civilization.

Today, agriculture is the largest global enterprise on earth. And while some regions still farm in ways similar to our ancient ancestors, for most of the world the mechanization of planting and harvesting, chemical fertilization and pest control, advanced irrigation, and other modern farming tools and techniques led to increased crop output—which, in turn, became a major contributing factor to rapid population growth.

By 1900, the global population was roughly 1.7 billion people. In 2050 it is expected to exceed 9.5 billion. That's more than 450% increase in the total number of people over the last 150 years. With billions more mouths to feed, there are increasing pressures on our global food supplies: less farmable land, more water pollution, growing water scarcity, increased fuel costs (making importing and exporting food more expensive), pesticide resistance, and the growth of megacities, to name just a few. In order to feed the world in the future, we will have to come up with smart new ways to grow our food much closer to where we live**.**

Your challenge: Choose two foods (one vegetable and one protein) and design a way to grow enough of each within your future city borders to feed all of your citizens for at least one growing season. Taking into account your city's size and location, you must consider the critical elements needed to grow food including light, climate, air quality, space, water, soil, and nutrients.

After your research, you will write a 750 word essay on this topic.

1. INTRODUCTION: DEFINE THE PROBLEM

- Briefly introduce your future city and describe its population, location, climate, landscape and general layout. Explain what problem(s) your future city solved by growing two foods within the city limits.
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2. BODY: DESCRIBE YOUR SOLUTION

- Introduce the two foods you've chosen, one vegetable and one protein (either plant or animal), and explain why you selected them.
- Explain how the foods meet the nutritional needs and food preferences of your city's residents.
- Describe the farm environment(s) you designed to grow your foods. Explain how it works, where it is located, and why it's the right solution for your future city.

- Explain how your design meets your two foods' basic requirements for light, soil, water, nutrients, temperature, air quality, and space and if these needs change during the growing season (e.g., from planting or birth to harvest).
- Share how your farm environment(s) produces enough of each food to supply all of your citizens for at least one growing season. (Note: Your two crops will not be the only food available to your citizens, but you do need to make sure you produce enough for everyone.)
- Explain how your urban farm solution is energy efficient.
- Discuss the tradeoffs/compromises connected with your urban farm and how your design reduces or eliminates these tradeoffs.

3. CONCLUSION: SUMMARIZE YOUR SOLUTION

- Summarize why the urban farm you designed is a good way to provide local, healthy abundant foods for your future city

Resources

Use these online and print resources to help launch research.

AGRICULTURAL TIMELINES

http://www.agclassroom.org/gan/timeline/farm_tech.htm

http://inventors.about.com/library/inventors/blfarm1.htm

http://www.robinsonlibrary.com/agriculture/agriculture/history/ timeline.htm

http://www.agclassroom.org/gan/timeline/

THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE

http://www.usatoday.com/story/news/nation/2013/02/05/climate-change-agriculture-study/1893455/

http://www.monitor.co.ug/Magazines/Farming/How-climate-change-affects-farming-practices/-/689860/1872914/-/lhmawoz/-/index.html

http://www.pnas.org/content/104/50/19691.long

THE BENEFITS AND/OR IMPORTANCE OF URBAN AGRICULTURE

http://www.good.is/posts/five-reasons-why-urban-farming-is-the-most-important-movement-of-our-time

http://www.ruaf.org/node/513

EXAMPLES OF URBAN FARMS

http://inhabitat.com/hundreds-of-vacant-detroit-lots-to-become-worlds-largest-urban-farm/

http://inhabitat.com/edible-austrian-pavilion-scoops-first-runner-up-for-the-2015-milan-expo/

http://www.verticalfarm.com/

http://content.time.com/time/specials/packages/article/0,28804,1934027_1934003_1933961,00.html

http://science.howstuffworks.com/environmental/conservation/_issues/vertical-farming.htm

http://content.time.com/time/magazine/article/0,9171,1826271,00.html

http://urbanharvest.org/

http://lufa.com/en/

http://environment.nationalgeographic.com/environment/_photos/urban-farming/

GREENHOUSE & HYDROPONIC LINKS

http://aces.nmsu.edu/pubs/_circulars/circ556.html

http://ag.arizona.edu/ceac/

http://ag.arizona.edu/ceac/sites/ag.arizona.edu.ceac/files/pls217nbCH5_1.pdf

http://www.howardresh.com/Articles-news.html

http://www.cornellcea.com/resourcesPublications/growersHandbooks/lettuce.html

GENERAL AND HIGHLY RECOMMENDED

http://content.time.com/time/photogallery/0,29307,1913033,00.html

http://blogs.worldwatch.org/nourishingtheplanet/

ASABE Resource Magazine, March/April 2013, Controlled Environment Agriculture
http://bt.e-ditionsbyfry.com/publication/?i=148288&p=4

http://www.asabe.org/

Popular Science, August 2009, "The Future of Farming: Eight Solutions for a Hungry World"
http://www.popsci.com/environment/article/2009-07/8-farming-solution-help-stop-world-hunger

https://disneyworld.disney.go.com/attractions/epcot/living-with-the-land/

VIDEOS

The Future of Farming
http://www.uctv.tv/farming/

Ted Talk: Mohamed Hage of Lufa Farms
http://www.youtube.com/watch?v=kSQm09twKEE

Food Forward: Pilot Episode, Urban Farming Across America
http://video.pbs.org/video/2276862085/

Resource Centres on Urban Agriculture & Food Security. A list of videos and slideshows on urban agriculture. http://www.ruaf.org/node/1527

GOOGLE WORD SEARCH SUGGESTIONS

Urban Farms

Urban Agriculture

Vertical Farms

Rooftop Gardens

Food Security

Food Safety

Food Technology

Aquaculture

Hydroponic

Aquaponics

Container Gardening

Agricultural Engineering (or Bioresource Engineering)

Biosystems Engineering

The Future of Farming

Climate Change and Agriculture

Use MLA for citing sources.

Draft Essay Using the Design Process

When engineers design solutions to problems, they go through a process of brainstorming, testing different ideas, learning from mistakes, and trying again. This is called the **engineering design process.** The steps of the engineering design process are:

- define the problem to solve;
- brainstorm various solutions;
- select a solution;
- design, build, test and redesign solution; and
- share results.

The engineering design process is a great way to work through any challenge that involves creating something that didn't exist before, such as building a bridge, planning a trip—even writing an essay. You'll use the design process as a framework to guide students through researching and writing their essay solutions.

1. Define the Problem

Define the problem by reviewing **this year's topic** and **Essay Outline**.

How would you describe the essay problem using your own words?

What are the different parts of the problem?

AGRICULTURAL PRACTICES—PRESENT, PAST, AND FUTURE

The next step in defining the problem is to develop a background understanding of the topic area. Research traditional farming practices, existing urban farms, and futuristic urban farm designs.

Start with exploring case studies of futuristic farm environments and then start mining the resource section on page 26.

Create a series of questions to guide your study of farms and agriculture.

Here are some questions to get started:

- Was this farm built new or did it utilize existing structures?
- What factors were used to decide the farm's location?
- What is the farm's source of light?
- How does the farm get water? Is there an efficient irrigation system?
- Is it climate controlled? Why or why not?
- Do they use pesticides? Should they?
- How are nutrients provided to the plants or fed to the animals?
- Is the farm energy efficient? Why or why not?
- What environmental impact does the farm have on the surrounding area and how will you lessen any negative consequences? For example, does your farm recycle waste product(s)?
- What **tradeoffs** does the design require?

FOOD AND NUTRITION

Before you can make your two crop choices, be aware of which plant-based crop will provide the most vitamins and minerals and which protein-based food will be nutritious and practical for an urban farm environment. You will need to understand where they get protein in your own diet. Meat, poultry, eggs, fish, legumes, most seeds and nuts, and several vegetables are all high in protein. But each has different growing requirements that must be taken into consideration.

Some foods, such as grains (wheat, rice, barley, etc.) are needed in such huge qualities and have such unique growing and harvesting requirements, that they are unlikely to be practical in urban farms. Other crops require such long growing cycles that the yield would not meet the needs of your students' city. It is also important to understand that food preferences are often rooted in cultural or ethnic traditions, which must be considered when choosing which foods to grow. As they research food options, students should consider:

- Are some foods easier to grow in your future city's location?
- Are there foods that are more culturally appropriate and desirable to your citizens?
- What nutritional benefits do these foods provide?
- How long does it take to produce a crop (either plant or animal)?
- What is the typical crop yield of these foods on a traditional or urban farm?
- Can they be grown in an energy efficient way?
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2. Brainstorm Various Solutions

Using what you already know from the case studies and research, brainstorm a range of foods and urban farm designs. Think about which solutions interest you, including those in use today and those being developed for tomorrow.

As you brainstorm be sure to include creativity, innovation, problem solving, and futuristic thinking. Your urban farm solution can be an improvement on an existing technology or a completely new invention. It can be a single centralized solution or one that involves a network of urban farms scattered throughout the city. Whatever the final design is, it should demonstrate original ideas.

3. Select a Solution

From their initial research and brainstorming, you must make four key decisions:

1. Which two foods will you grow within the boundaries of the city limits?

- One must be a vegetable, the other must be a protein.
- You must grow enough of each to feed the entire city. (Remember their two foods aren't the only food the citizens will eat, but there should be enough for everyone.
- It must be nutritionally beneficial.

2. What does your urban farm design(s) look like? How will it work?

- How does it meet the crops basic growing needs for light, soil/growing medium, water, and nutrients?
- Are there tradeoffs you will need to address? What are they?
- Can you grow both crops in one environment or do they need multiple designs?

  3. What makes the design energy efficient?

  4. Where is it located in the city? (This is the portion of the city for the model).

4. Design, Test, and Redesign

As you develop a design and start outlining it, it is likely you will need to refine your ideas and solve problems that develop. This is part of the process.

At this stage it is good idea to rely on these resources to make sure we are heading in the right direction:

1. The **Rubric** outlines the criteria we will use to evaluate the research essays.
2. The **Essay Outline** provides a basic outline of how to structure the essay.

5. Share Results

Now it's time for you to finalize their essay and share your ideas.

 The essay should be no longer than 1,000 words and free of grammatical and spelling errors.

You should cite at least three sources of information used during the idea development process.

 Use a variety of sources of information, such as interviews with experts, reference books, periodicals, and websites. *(NOTE: Wikipedia is not accepted as a source of research.)*

ESSAY RUBRIC

	0 points	1 point	2 points	3 points
1. Describe city & agricultural capabilities: • Introduce city: location, geography, development, etc. • Factors affecting agriculture: geographic, demographic, climatological, cultural, etc.	No description of city or agricultural factors	Brief description of city and agricultural factors.	Good description of the city, its agricultural capability, and the factors that affect it.	Detailed description of city, its agricultural capability, and the factors that affect it.
2. Describe urban agriculture needs and resources: • Food needs of city/citizens • Resources the city can devote to agriculture	No description of needs or resources.	Brief description of needs or resources.	Good description of needs or resources	Detailed description needs or resources.
3. Describe the solution • Crops and why they were chosen • Urban farm environment and resources • Considerations throughout the agricultural cycle	No description of solution.	Brief description if solution but few details.	Good description of the solution.	Excellent description of solutions, fully detailed and explained.
4. Describe technology and infrastructure required • Describe technology involved • Discuss infrastructure required	No description of technology or infrastructure.	Brief description of technology.	Good description of technology.	Excellent description of technology.
5. Discuss key elements • Light, climate, air quality, space, water, soil, and nutrients	No discussion of key elements.	Some discussion of key elements.	Good discussion of key elements.	Excellent discussion of key elements.
6. Risks, benefits and tradeoffs • Consider risk areas such as: environmental factors, location, chemicals, air quality, waste, and recycling • Discuss benefits that urban farming and this solution bring to city and citizens	No consideration of risks and benefits..	Brief description of at least one risk and benefit.	Good description of potential risk areas and benefits of the solution.	Excellent description of risks and the benefits of this solution
7. Effectiveness of solution in meeting requirements • Selection of crops meets needs of citizens • Clever design and application of	Not effective. Does not meet	Solution is fairly effective, but both crop choice and	Solution is effective, but either crop choices	Design is a highly effective, with good

technology • Accounts for key elements: light, climate, air quality, space, water, soil, and nutrients	required elements.	technology design can be better.	or technology design could be improved.	choice of crops and excellent technology design that accounts for all key elements.
8. Innovative and futuristic solution	Not innovative or original. Not futuristic.	Somewhat original or innovative.	Solution is innovative, original and somewhat futuristic.	Solution is highly innovative, original and futuristic.

9. Plausibility of solution • Based on sound scientific principles	Implausible or not scientifically sound.	Solution is not very plausible (science fiction).	Solution is somewhat plausible, but needs to be more scientifically sound.	Solution is highly plausible and scientifically sound
10. Organization	Poor organization.	Fair organization.	Good organization.	Excellent organization.
11. Writing Skills	Poor writing..	Fair writing.	Good writing	Excellent writing.
12. Grammar and spelling	Many errors.	Some errors.	Very few errors.	No errors.
13. Resources used and cited	No resources	Less than three Resources.	At least three valid resources.	More than 3 resources.