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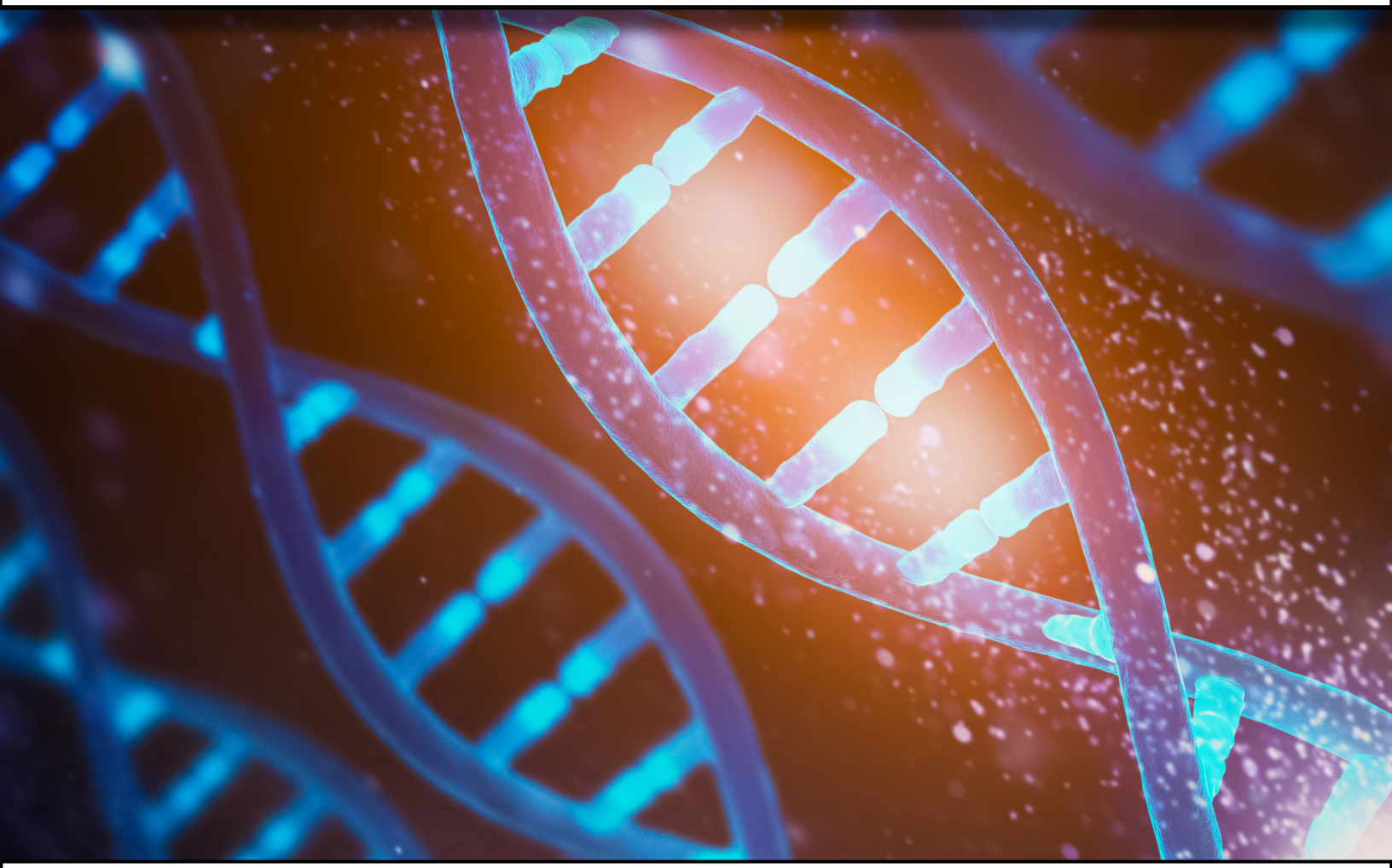
SCIENCE *for Global Goals*

BIOTECHNOLOGY!

How can we ethically create a sustainable future using biotechnology?



SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian *Science Education Center*

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iap SCIENCE HEALTH POLICY

the interacademy partnership

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Biotechnology!
How can we ethically create a sustainable future using biotechnology?
Community Research Guide

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Smithsonian Science Education Center

The Smithsonian Science Education Center (SSEC) is operated by the Smithsonian Institution to improve the teaching and learning of science for students in the United States and throughout the world. The SSEC disseminates information about exemplary teaching resources, develops curriculum materials, supports the professional growth of science teachers and school leaders, and conducts outreach programs of leadership development and technical assistance to help school districts implement inquiry-centered science programs. Its mission is to transform the teaching and learning of science in a world of unprecedented scientific and technological change.

Smithsonian Institution

The Smithsonian Institution was created by an Act of Congress in 1846 "for the increase and diffusion of knowledge . . ." This independent federal establishment is the world's largest museum, education, and research complex and is responsible for public and scholarly activities, exhibitions, and research projects nationwide and overseas. Among the objectives of the Smithsonian is the application of its unique resources to enhance elementary and secondary education.

Smithsonian Science for Global Goals (SSfGG) is a freely available curriculum developed by the Smithsonian Science Education Center (SSEC) in collaboration with the InterAcademy Partnership. It uses the United Nations Sustainable Development Goals (SDGs) as a framework to focus on sustainable actions that are student-defined and implemented.

Attempting to empower the next generation of decision-makers capable of making the right choices about the complex socio-scientific issues facing human society, SSfGG blends together previous practices in Inquiry-Based Science Education (IBSE), Social Studies Education (SSE), Global Citizenship Education (GCE), Social Emotional Learning (SEL), and Education for Sustainable Development (ESD).

Thank You for Your Assistance

Thank You for Your Support

This project was supported by Johnson & Johnson through Grant GBMF#70997531 to the Smithsonian Science Education Center.

How can we ethically create a sustainable future using biotechnology?

Part 1: Introduction to Biotechnology	• Task 1: What is a sustainable future? • Task 2: How can biotechnology help create a sustainable future?
Part 2: Biotechnology and Food Systems	• Task 1: Should we use biotechnology to change the food we eat? • Task 2: How can biotechnology help food systems contribute to a more sustainable future?
Part 3: Biotechnology and Materials	• Task 1: How can biotechnology change the materials we use? • Task 2: Can we create the materials we need using cells and biotechnology?
Part 4: Biotechnology and Human Health	• Task 1: How can we diagnose diseases using biotechnology? • Task 2: How can we fix genetic diseases using biotechnology?
Part 5: Biotechnology and Genetic Data	• Task 1: How should we use and protect genetic data? • Task 2: How can environmental genetic data help identify and solve problems?

Part 6: Biotechnology and the Environment	• Task 1: How can biotechnology make our communities cleaner?
	• Task 2: How can biotechnology help restore biodiversity to ecosystems?
Part 7: Biotechnology and Security	• Task 1. How can biotechnology help with security?
	• Task 2: What are the threats to security presented by biotechnology?
Part 8: Taking Action	• Task 1. How will I help create a sustainable world using biotechnology?

Smithsonian
Science Education Center

Director Letter

Dear Parents, Caregivers, and Educators,

As a global community we face many challenges. At times, these worldwide problems can seem overwhelming. We may ask ourselves questions about how to understand these complex problems and whether there's anything we can do to make them better. This community response guide encourages young people to discover, understand, and act on the answers to these questions.

In the years leading up to 2015, people around the world worked together to share their ideas about how our world should be. These ideas became a list of goals, the United Nations Sustainable Development Goals. The goals represent a plan for a sustainable world: a world where peaceful societies collaborate; a world where we live in balance with the environment of our planet; a world in which our economies fulfill our needs; a world that is fair to all.

As youth around the globe engage with the activities in this guide, they will gain an understanding of the science that underlies the Sustainable Development Goals. They will be able to share their knowledge with their community, create tangible ways to help their community make informed decisions, and understand the best places to find additional information on these topics.

Throughout the guide, young people may find themselves asking many questions about fair treatment of people and communities. You do not need to have the answers to any of these questions. The most important thing you can offer young people is the opportunity to question, investigate, think critically and systemically, synthesize, and act. Ask the young people around you how they are feeling and what they are thinking about as they learn this content.

I am immensely grateful to the experts who helped to develop this guide—the InterAcademy Partnership, a collaboration of 140 national academies of sciences, engineering, and medicine; our colleagues across the Smithsonian Institution; and the external subject matter experts who contributed to this guide—for their perspectives and technical support in ensuring the science in this guide is accurate. I also want to say a special thank you to the developer of this guide, Heidi Gibson, for her thoughtful contributions to the *Smithsonian Science for Global Goals* project.

Working together—scientists, researchers, parents, caregivers, educators, youth—we can make a better world for all. This guide is a step toward that grand collaboration.

Thank you for partnering with us to inspire our youth to build a better world.

Best,

Carol L. O'Donnell

Dr. Carol O'Donnell, Director
Smithsonian Science Education Center

About this Community Research Guide

The goal of this guide is to prepare young people to take considered action on pressing global issues. Considered action means young people learn about a problem, connect it to the larger system, consider all the complexities of the problem, decide for themselves the best way to address it, and then execute a solution. Through this process young people are prepared not only to take considered action on a specific issue, but to build the skills needed to take action on all issues that affect them and their communities.

Figure 1: Sustainability Mindsets.

Learners use scientific and socio-scientific investigations to understand their local communities, scientific principles, and innovation possibilities. They then have a chance to immediately apply this information to make decisions that are informed by the results of their investigations. Along the way, young people are prompted to reflect, investigate, think critically, analyze, and build consensus. Engaging in these activities builds important skills of empowerment and agency, open-mindedness and reflection, equity and justice, and global-local interconnection. These sustainability mindsets prepare young people to take an active role in shaping the future of their communities and their world.

A Framework to Discover, Understand, and Act

Throughout the guide, young people are prompted to Discover, Understand, and Act. The three parts of their learning journey are described here.

Discover

Young people already have a lot of information and opinions about the world around them. In this guide, they are prompted to use that knowledge as an entry point. They will discover what they already know and what questions they might have. They are encouraged to consider different perspectives and priorities. This both empowers young people and provides an immediate relevance and context for their investigations.

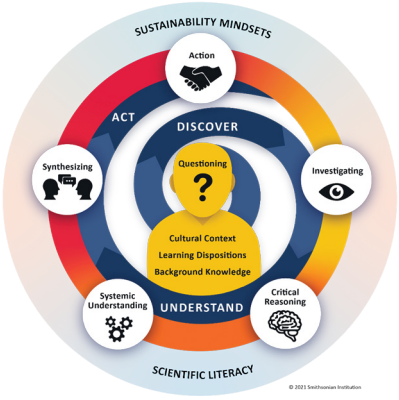

Figure 2: Global Goals Action Progression.

Understand

Gathering new information is a primary goal of science. Using a wide variety of methods to do so helps young people understand the problems related to sustainable communities. They need to understand the problems both abstractly and within the context of their local community. Designing and conducting real-world investigations and interpreting results encourages young people to think like scientists.

Act

Finally, young people apply both their existing knowledge and their newly gathered information. First, they consider personal changes they could make to help make their communities more

sustainable. Then, as a team, young people find consensus on what they *could* do, what they *should* do, and what they *will* do. Teams then take action and reflect on the consequences, both intended and unintended.

Pedagogy Shift

This guide may feel like a big shift from the standard method of teaching. The guide is:

Led by Young People

To make progress toward a better world, we need the ideas, enthusiasm, and energy of every young person. We need them to help design and build the world in which they want to live. This means throughout the guide young people make authentic decisions about what and how they will learn. Their goal is to understand issues in their own community and take sustainable actions to make their community and their world better.

Driven by Data Collected by Young People

In this guide, the young people you teach will become action researchers. They will gather information about what sustainable communities mean in their own local spaces. This includes scientific investigations and experiments to understand the problems better, and also using social science methods to understand their community better. Using science and social science helps young people arrive at a sustainable solution.

Focused on Action

The goal of the guide is to help young people not just learn but also do. Throughout the guide young people will conduct investigations and then use that knowledge to make decisions about the actions that would be best for their community. They will then put those decisions into practice and see the results of their actions.

Customized for Local Communities

Each community is unique. While the world has global problems, the solutions must work locally. Young people already have tremendous knowledge about their local community. This guide prompts them to use that knowledge and find out new information to figure out solutions that are sustainable in *their* community.

Structure of this Community Research Guide

Parts

This guide is made up of eight parts. Each part works with the others to help learners understand how to help their community thrive and to put that knowledge to work by taking action.

However, we recognize that time is a limiting factor in many learning spaces. Therefore, the guide is designed flexibly so it can be shortened, if necessary. The learners are guided to do this shortening work themselves at the end of Part 1. The guide prompts learners to discuss with their teacher how much time is available and then make decisions about the best way to use that time.

Tasks

Within each part there are two tasks. Each task helps learners examine a different aspect of the topic they are exploring. Within each task, there are three activities, which correspond to the Discover, Understand, Act framework. Discover activities focus on existing learner knowledge. Understand

activities focus on gathering new information. Act activities focus on analyzing and applying that new information to make decisions. Tasks also include perspectives and stories from experts around the globe, so students can connect with the work of real-world scientists.

Using this Guide

Roles

The Learner's Role

Learners are the decision-makers of the guide. They will decide what information they need and what the information they gather means. Then learners use that information to decide and implement actions.

The Teacher's Role

This guide may be challenging for learners, since they may be unfamiliar with their role. Learners may need assistance in deciding what to do. Support and help them, but do not decide for them. Be patient. There are no right answers to the big questions posed by this guide.

Adapting the Guide for Your Context

Different Ages

This guide is designed to be used with young people between the ages of 8 and 17. This large range is deliberate to give access to these ideas to as many young people as possible. If you teach learners who are on the younger end of the age range you may need to support them a little more. For example, you might need to:

- Explain more complex words or topics
- Promote listening and tolerance in group discussions
- Support group decision-making
- Help them plan investigations in their community or accompany the teams on their investigations
- Help learners think through the feasibility of the action they plan
- Present alternate ways of capturing ideas; for example, if the guide suggests learners write, but that is too difficult or is inappropriate for your learners, they can always draw, act out, or just talk about their ideas

If you teach learners who are on the older end of the age range, the language of the guide might seem a little simple. However, older learners who can understand more complex ideas will be able to develop a more nuanced view of the problem and come up with more extensive solutions.

All young people should be able to engage with the guide in a way that is developmentally appropriate for them.

Different Resources

We have assumed you have very basic classroom resources, such as a class board (blackboard or whiteboard), paper, and pens or pencils. If it is not possible to capture learner writing, you can always have learners act out or discuss their ideas. If you do not have the capacity to print out a Community Research Guide for each learner, you or learner leaders can read the guide out loud from a single print or digital copy.

Accessibility

This guide is designed to be widely accessible. The language, tone, and format attempt to be as inclusive as possible to reach learners with a wide variety of learning styles. However, learners with specific needs may need teacher support. As mentioned earlier, the guide activities can always be adapted to fit learner abilities, either by you or by the students themselves.

Different Rules

Each place is different and may have different rules to protect young people and privacy. For example, in Part 7 of this guide there is an activity where young people explore using their fingerprints as biometric identification. Educators should follow local area guidance or regulations about privacy.

Extensions

For each part and many tasks there are additional activities, videos, and resources available digitally. They can all be found at the *Biotechnology!* StoryMap at https://bit.ly/3pQUDpc.

Teams

Much of the research, decision-making, and action is designed to be done in teams. These teams can range in size from a group of two or three learners to the whole class. As a teacher, this is something to consider before beginning the Community Research Guide.

If you have motivated and responsible learners who need minimal teacher support, you may want to break your class into small teams. Smaller teams will allow individual learners to share their opinions and have more of an impact on team decision-making. With smaller teams, the experience can be more customized to the interests of the individual learner because there are fewer interests represented.

If you have learners who need more support, you may need to keep the class together in one team or have one team for each adult in the class. If you have only one team per adult, an adult can help support learners directly while they are engaging in activities such as conducting investigations and making decisions. However, because the team is larger, individual learners will have less of a voice in decision-making and less impact on group actions.

Alternately, if you have a group of learners with mixed abilities, you can design groups that bring together learners with different strengths. These types of groups can help learners support one another rather than immediately turning to an adult for support.

If you are uncertain whether a small or large group is most appropriate for your learners, you may want to wait and observe them during Task 1. In Task 1 in the Understand activity, learners break into groups and conduct investigations. If learners are able to complete this task independently with fairly limited teacher support, they would probably be successful in a small group. If learners need a great deal of help to complete this activity, you may want to structure group size so they can have more focused adult support throughout the Community Research Guide.

Getting Started

We recommend you give the young people you work with the Student Letter to read. You may also find it useful to read through each part of the Community Research Guide in its entirety before beginning that part. We suggest you encourage your learners to be excited about this new learning adventure. Be prepared to be enthusiastic about their ideas.

Student Letter

Dear Student,

This is the last time you will be called a student in this Community Research Guide. Instead, you will take on a new role as an action researcher. Action researchers are interested in figuring out what to do to make their communities better. They use scientific investigations to help understand the natural world around them. They use social science investigations to help understand the people, cultures, and history of their communities. Then they use the information they gather to help solve problems in their own communities. This guide will help you learn more about this process. The most important thing to know is that you will control your own research and make your own decisions.

Think back to a time when you solved a problem. You first needed to know what you wanted—your goal. Then you needed to figure out what you needed to do to achieve your goal. This guide is similar. You will think about goals you have for your local community, then figure out what you need to take action to help reach those goals.

You and your classmates will work as a team to think about information you already have about the place where you live. Then you will investigate your local community and how things work. Finally, your team will decide how to make things better. Together, you will put your decision into action. Sometimes making decisions about what to do is difficult. Don't worry, this guide will give you lots of support.

How to Use this Guide

This guide is designed to help you explore and think about problems in your community. The guide is here to help you. That means you can always change it.

Adapting the Guide

You will notice that in this guide there are often suggestions about different ways of sharing your ideas or doing investigations. This is because different people think and work best in different ways. For example, some people like to draw, some people like to talk out loud, and some people prefer to write to express their ideas. This guide has suggestions, but you can always change the method suggested. You can share your

ideas using discussions, acting, signing, telling stories, recording your voice, writing by hand, typing on a computer, drawing, or another way you choose. Think about the way you and your team learn best together. Including everyone on the team is important.

Safety Tips

This guide asks you to do and think about things that may seem unfamiliar. You will notice physical and emotional safety tips in the guide. These will help you stay safe and supported during the activities. Make sure you follow your teacher's directions about staying safe.

Guide Structure

There are eight parts in this guide. Most parts have two tasks. Each task has three activities. The activities are called ***Discover***, ***Understand***, and ***Act***. In the ***Discover*** activities you will focus on thinking about information you and your team already know. In the ***Understand*** activities you will investigate to find out new information. In the ***Act*** activities you will put your existing and new knowledge into action by applying it and making decisions. Words that may be unfamiliar will be in **bold** the first time they are used. Then at the end of each part a glossary lists the definitions of these words.

Investigations

You are the one doing the research in this guide. This means often you will develop your own questions and determine the best way to answer them. Developing and answering questions is how scientists find out new information about the world around them. As an action researcher, you need to think like a scientist to discover what you need to know, investigate to find out more information, and think about the meaning of what you found out.

Keeping Organized

In this guide you will have some papers you will need to keep so you can look at them later. You may want to have a folder, notebook, or science journal to help you stay organized.

Teams

You will be working with other classmates as part of a research team. Your team will conduct investigations and make decisions together. When conducting research, there may be many things to figure out as a team. You will need to be creative. There will not always be a clear right and wrong answer. Sometimes the team might not agree. This is okay. Just make sure to respect your teammates. There is no one right answer to the problems faced by your community. There is just the right answer for you and your team.

Getting Started

You will be thinking about complex problems. Sometimes this can feel difficult. Be patient. You will be guided to consider different parts of the problem. By the time you are making big decisions, you should have lots of information. Always remember, your work is important. Decisions you make can change your community. You are an important part of making your local and global communities better.

Thank you for working to make your community better.

The Smithsonian Science for Global Goals team
Smithsonian Science Education Center
Smithsonian Institution

