BioBLAST® Complete Sequence

Phase	Suggested Activities for Each Phase				
Preparation	1. Teacher Preparation and Planning	1. *BioBLAST* Pretest	1. Set Up Software and Long-Duration Labs	1. Set Up Software	1. Intro. to Research Journal
Orientation	2. Journey into Space	2. Beginning Exercises	2. Journey to the *BioBLAST* Lunar Base	2. Using Models to Study Biological Systems	2. Research Agreement
Research: Human Requirement	3. Human Req. (HR) Issues	3. HR Labs	3. HR Computer-based Activities	3. HR Analysis	3. Student Research Progress Report 1
Research: Plant Production	4. Plant Production (PP) Research Issues	4. PP Labs	4. PP Computer-based Activities	4. PP Analysis	4. Student Research Progress Report 2
Research: Resource Recycling	5. Resource Recycling (RR) Research Issues	5. RR Labs	5. RR Computer-based Activities	5. RR Analysis	5. Student Research Progress Report 3
Mission	6. Integrate HR, PP< and RR into Build a BliSS (BaBS) design	6. Analysis of BaBS trial run and areas to correct and/or optimize	6. Analysis of long-term labs.	6. Final BaBS run and report.	6. Student Research Progress Report 4
Conclusion	7. Individual Research Projects	7. Posting lab and simulation analysis	7. Complete research agreement	7. Research sharing, peer reviews and publishing	7. *BioBLAST* Posttest

BioBLAST® Proposed Sequence

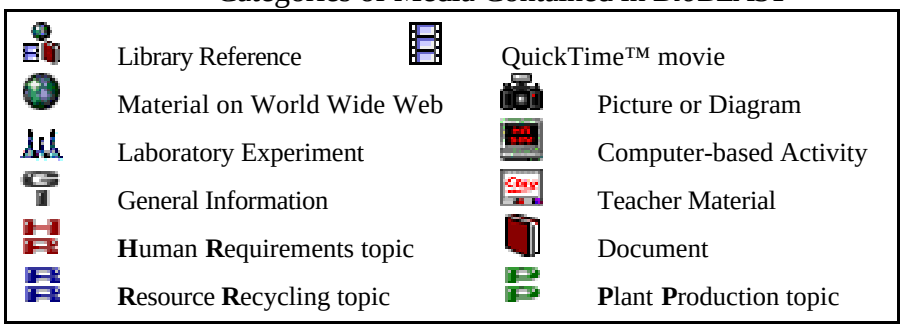
1. Teacher Preparation and Planning

BioBLAST is a curriculum supplement that may be incorporated into the beginning, end, or throughout your high school biology curriculum. During the development of this program we have worked with NASA scientists and science teachers from throughout the United States to get feedback on the software interface and activities, laboratory experiments, paper-and-pencil exercises, and reading materials. Based on evaluation, feedback, and on-site testing with lead teachers, we have developed a suggested sequence for weaving *BioBLAST* materials into the biology curriculum as an integrated math, science, and technology curriculum enhancement. Consider this sequence a road map to the materials contained on the *BioBLAST* CD-ROM and web site.

For your first time implementation of *BioBLAST*, the curriculum sequence will help you adapt the materials provided to suit your resources and class schedule. Once you are more familiar with the suite of materials provided on the *BioBLAST* CD-ROM and web site, you can develop your own curriculum sequence that best fits your school's goals for science, math, and technology curricula. We encourage teachers to collaborate with their colleagues in related disciplines in the implementation of *BioBLAST*. We provide a complete sequence and four *BioBLAST* samplers for those who don't have as much time to do *BioBLAST*.

The BioBLAST CD-ROM contains a variety of media that you can incorporate into your curriculum. The key below identifies the symbols used to provide a quick reference regarding the media type for resources mentioned in the sequence.

Categories of Media Contained in *BioBLAST*



The ***BioBLAST*** Sequence is organized in these five phases:

A. Preparation	B. Orientation	C. Research	D. Mission	E. Reporting

Don't have time to do all of BioBLAST? Start with a BioBLAST Sampler

Four "Sampler" sequences are available for students to try a *taste* of *BioBLAST.* Each sequence is designed to take approximately five class periods, and each includes the launch sequence, an experiment, a simulator activity, and several explanatory movie clips. The focus of Samplers 1 is human requirements; the focus of Sampler 2 is plant production; the focus of Sampler 3 is resource recycling. Sampler 4 integrates the three major content areas and gives students hands-on experience with using a computational modeling system to test hypotheses and conduct sophisticated data analysis.

In addition to providing examples of *BioBLAST* activities, the samplers also provide students with an opportunity to use the *BioBLAST* computer interface as they virtually travel throughout the lunar base. The intent is to encourage student interest in computer-based tools that enhance scientific inquiry. The samplers can provide a *BioBLAST* experience when time does not allow for the entire program to be used. The themes behind each of the four samplers are described in Figure 1 below.

Figure 1. BioBLAST Samplers

Sampler	**Suggested Activities for Each Sampler**				
Sampler 1: Human Requirements	Launch to Lunar Base & Human Requirements Investigation #1	Effects of Exercise on Respiration & Pulse Experiment	Enter Data and Conduct Analysis	Human Requirements Investigation #2	Report Results and Share Findings
Sampler 2: Resource Recycling	Launch to Lunar Base & Plant Production Investigation #1	Effects of Light Intensity on Plant Growth Experiment	Enter Data and Conduct Analysis	Launch to Lunar Base & Plant Production Investigation #2	Report Results and Share Findings
Sampler 3: Plant Production	Launch to Lunar Base & Recycling Investigation #1 or #2	Gray Water Experiment	Enter Data and Conduct Analysis	Launch to Lunar Base & Recycling Investigations #3, #4, or #5	Report Results and Share Findings
Sampler 4: How Scientists Use Models	How Scientists Use Models and Using Biological Models Effectively	Introduction to Build a BliSS Simulator (BaBS): A biologically-based life support system	Review strengths and weaknesses of BaBS Run Provided	Design and Test "Optimized Run"	Report Results and Share Findings on BaBS Simulation Activity

Table of Contents of Activities Suggested for Each Phase of *BioBLAST*

Preparation Phase: Events 1 - 5

Event 1: Teacher Preparation and Planning

In this phase teachers prepare to begin *BioBLAST* and address the tasks:

- planning your class schedule for *BioBLAST* labs, computer-based activities, and student research projects;
- ordering lab supplies;
- scheduling access to computer facilities and resources needed;
- registering for the Ask a NASA Expert program.

Use the suggested sequence as a way to become familiar with the materials provided on the *BioBLAST* CD-ROM and web site. The suggested sequence provides:
(1) An inventory of the software, documents, *QuickTime* movies, and traditional experiments provided on the *BioBLAST* CD-ROM and web site; and
(2) A sequential, curriculum-related plan for implementing the *BioBLAST* program that can be customized to different school schedules and resources.

Table 1: Documents in *For Teachers* Folder

Assessment Materials
Permission Form
Post-Test
Pre-Test

BaBS
Assessing BaBS Runs-Teach
BaBS Solutions Spreadsheet-CW
BaBS Solutions Spreadsheet-XL
BaBS Worksheet

Forms
BB Fax Inquiry Form
BB Test Teacher's Journal
Bug Report Form

Human Requirements Exp.
Calories/Exercise/Met-Teach
Calorimetry Exp.-Teach
Exercise Exp.-Teach
Medical Profiles-Teach
Respiratory Volumes Exp.-Teach

Journal Activities
Basic Journal Instructions
Intro to Journal Keeping
Looking Back on the Present
What Would Make You Go?

Orientation Activities
Extraterrestrial Activity-Teach
How Big/Far is the Moon?-Teach
How Much Room?-Teach
Molecular Masses-Teach
Related Videos
Water on the Moon-Teach

Other Math Activities
Metric Staircase-Teach
Rounding & Sig. Figs-Teach
Scientific Notation-Teach
T-Test Activity-Teach

Overview of CD
Read Me First
Using *BioBLAST* Software
Sample Sequence

Plant Production Exp.
Farming in Space Exp.-Teach
Gibberellic Acid Exp.-Teach
Imbibition Exp.-Teach
Light Intensity Exp.-Teach

Simulator Challenges
HR Challenge 1-Teach
HR Challenge 2-Teach
PP Challenge 1-Teach
PP Challenge 2-Teach
RR Challenge 1-Teach
RR Challenge 2-Teach
RR Challenge 3-Teach
RR Challenge 4-Teach
RR Challenge 5-Teach

Spreadsheet Activities
Are Your Meals Nutritious-Teach
How Big is a Serving-Teach
How Many Calories-Teach
How Much Do You Eat-Teach
Spreadsheet Info

Resource Recycling Exp.
Composting Solid Waste
Solid Waste-Ex 1
Solid Waste-Ex 2
Solid Waste-Ex 3
Solid Waste-Ex 4
Solid Waste-Forward
Decomposition Column Exp.-Teach
Gray Water Exp.-Teach
Transpiration Exp.-Teach

Writing Materials
Building Skills Reading/Writing

The *BioBLAST* CD-ROM includes:

75 QuickTime movies of NASA experts;
10 traditional lab experiments;
4 computer-based simulators that include 15 computer-based investigations;
75 interactive objects within 9 QTVR areas for virtual "walkthrough"
131 documents for students
A *For Teachers* folder with explanatory and assessment materials that includes 65 documents
Web site links to related NASA sites, *BioBLAST* web resources
Web link to *BioBLAST Ask a NASA Expert* Question and Answer system

Table 2: Introductory Material

Material Title	***Type***	***Location(Folder or Hot Spot #)***
Overview of CD		CD: For Teachers Folder/ Overview of CD
Read Me First		CD: For Teachers Folder
Using *BioBLAST* Software		CD: For Teachers Folder/ Overview of CD
Introduction to *BioBLAST*	 video	Videotape: A 10-minute introductory presentation
The Making of *BioBLAST*	 **QT**	An 8-minute QT™ movie contained on the *BioBLAST* CD-ROM
Lab Safety Videos & References		CD: Laboratory: **62**
Suggested Sequence		CD: For Teachers Folder/Overview of CD

Event 2: *BioBLAST* Pretest

Instructions for administering the pretest

- We would like you to administer the pre-test before you begin using the *BioBLAST* CD. We will also be asking you to administer a post-test once you have completed your work with *BioBLAST*. A comparison of these tests will help us assess the impact of the *BioBLAST* program on your student performance in the areas addressed in the pre- and posttests.

- Please share any comments you have regarding the pre-test. Many of the questions have evolved from the initial more open-ended test that was used in our early testing in the spring of 1997. You will also see that we have included several math-related questions that we have borrowed from existing standard testing materials. We want to look more closely to see whether *BioBLAST* has an impact on your students graph interpretation and other math skills. The simulations stress mathematical analysis, so it seems appropriate to address these skills in the program evaluation materials.

- Please follow these classroom procedures as much as you can so that our data can be as consistent as possible across schools.

Administer the pretest in paper format. Since this file is sent as a pdf file, all pretests should look the same when printed on any printer.

Allow your students 40 minutes to complete the test. It is very important that the same time be allowed for every class.

- Please have students complete the attached permission form also. The completed permission forms can be returned to the COTF at the same time as you mail back the completed pre-tests. Please mail the pretests and permission forms to us as soon as they are completed.

- Please ask your students to write legibly. Student responses will be keyed into a database at a later date, and it will be quite helpful if the handwriting is readable.

- Students should print their full names on their test. Although the names will later be coded to protect student anonymity and confidentiality, it is very important for research purposes that we initially have the student names on the tests.

- Thank you for your help. This is a very important aspect of our formative evaluation. We will share the pre/posttest rubric with you via the web site.

Support Materials for Pretesting - Event 2

Material Title	***Location***
Pre-Test	CD: For Teachers Folder /Assessment Materials
Permission Form	Will be distributed via the listserve - same as pre-test with revised instructions.
Pre/Posttest Scoring Rubric	http://www.cotf.edu/BioBLAST

Event 3: Set-up Long Duration Lab Investigations

Long-Duration Labs Requiring Advance Set-up would include some or all of the following:

Material	***Type***	***Location***	***Hot Spot #***
- Effects of Light Intensity on Plant Growth*		CD: Laboratory	**53**
- Effects of Gray Water on Plant Growth*		CD: Laboratory	**53**
- Decomposition Column*		CD: Laboratory; in notebook	**55**
- Composting: A sequence of three labs*		CD: For Teachers folder/RR Experiments/Composting Solid Waste	**-**

*A Teacher version of this activity is available in the For Teachers folder/Experiments folder

Event 4: Set-up Software

Refer to the following documents contained on the BioBLAST CD for instructions on setting up the software on your computers:

Read Me First
Using BioBLAST Software
Overview of CD

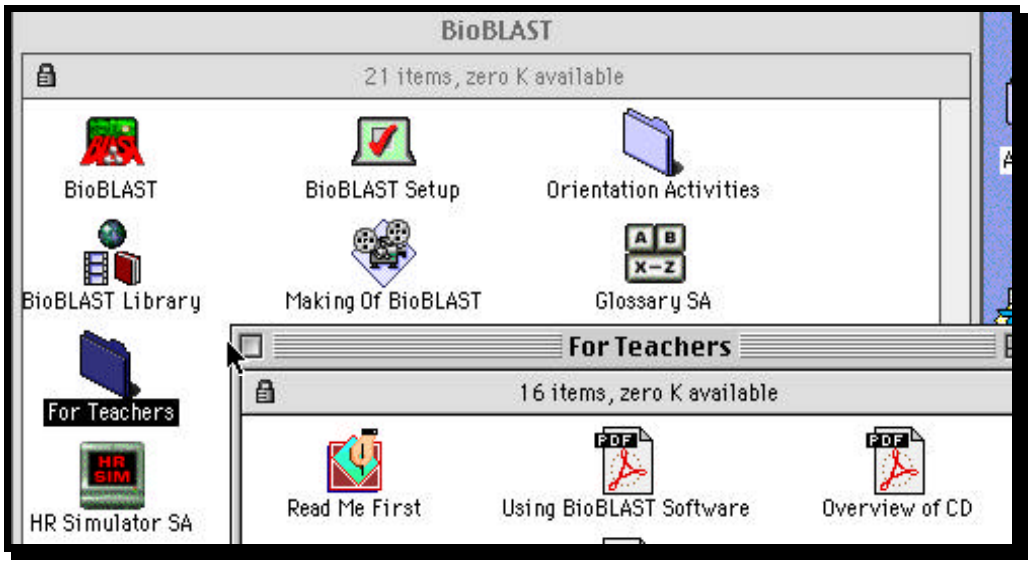


Figure 2. Your will find files for setting up software in the For Teachers Folder.

Run the BioBLAST Setup Program:

After you have installed Acrobat Reader and SuperCard Player (See Figure 3)

Figure 3. Install SuperCard Player and Acrobat Reader from the “Install Me” folder.

Event 5: Introduction to Research Journal

Figure 4 shows a listing of the support materials provided to help teachers introduce and create assignments associated with the BioBLAST research journal. The journal provided with the software can be saved by individuals student or by a student team onto a floppy disk, hard drive, or network. Please refer to the document titled "Basic Journal Instructions" to get more detailed information regarding how the journal operates.

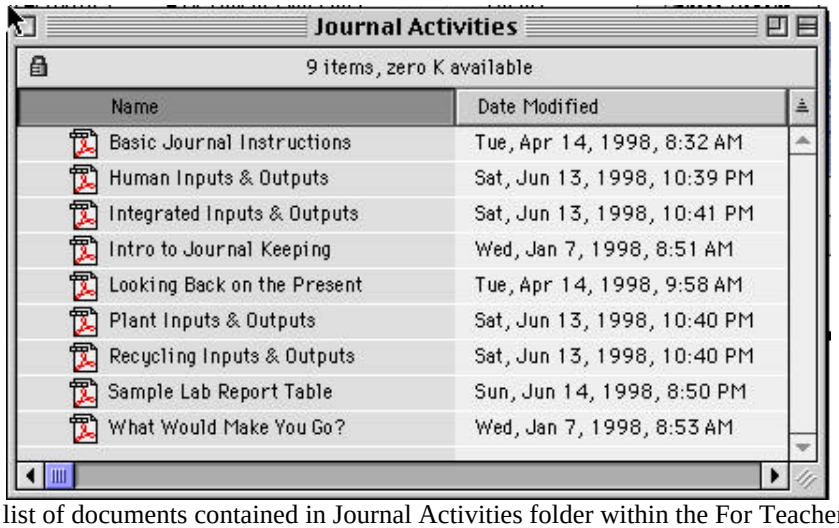


Figure 4. A list of documents contained in Journal Activities folder within the For Teachers folder that support research journal activities.

To stimulate student interest and ideas, we collected student journal entries from students who participated in the prototype testing of BioBLAST. Figure 5 shows one of these sample entries.

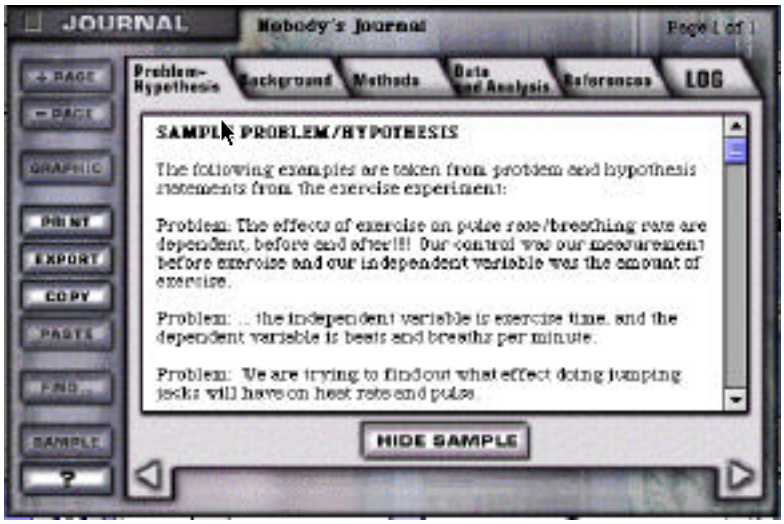


Figure 5. Illustration of a sample journal entry contained in the Problem Hypothesis Section.

Orientation Phase: Events 6 - 10

Event 6: Journey into Space

· Students begin the scientific process by engaging in background research and hands-on laboratory activities that introduce them to key concepts in *BioBLAST.*

Event 7: Beginning Exercises

Classroom Activities for **Orientation Phase**

Material	***Type***	***Location***
How Big/Far is the Moon?* How Big/Far is the Moon?* Water on the Moon* How Much Room Will You Have?* What Would It Cost?* Molecular Masses* Extraterrestrial Activity*		CD: Orientation folder

*A Teacher version of this activity  is available in the For Teachers folder/Orientation folder

The ***Launch Sequence*** can be done in 2 ways: Guided by computer or Selected by user.

Material	***Type***	***Location***	***Hot Spot #***
(1) Guided by computer - directed sequence		Select Launch Sequence when setting up journal. The directed sequence will display movies in a fixed order and students will select each item in sequence. Only the item next in sequence can be selected during the guided launch sequence.	
(2) Selected by user - sequence optional		Skip Launch Sequence when setting up journal. Use map to enter space ship and proceed through sequence. Below is the recommended sequence.	
Suggested sequence for launch:		All are in Space Ship	
(a) Launch Video		Green button in center	**12**
(b) Mentor Orientation 1		Video monitor, front, Angie's face	**1**
(c) Mission Briefing		Video monitor, right, NASA logo	**5**
(d) Mentor Orientation 2		Video monitor, right, Angie's face	**2**
(e) Tons O' TYNS		Video monitor, left, Tons O' TYNS screen	**7**
(f) Mentor Orientation 3		Video monitor, left, Angie's face	**3**
(g) Introductory Readings		Books on shelf, left, above Tons O'	**8**
(h) Landing Video		TYNS	**13**
(i) Lunar Base Tour Video		Red button in center Video monitor labeled Lunar Base Tour	**6**

Enhancement Materials on CD for **Orientation Phase**

Material	***Type***	***Location***	***Hot Spot #***
Moon images		CD: Space ship window	**9**
Solar system images		CD: Space ship	**10**
Space Ship Controls		CD: Space ship	**21**
Outdoor Equipment Images		CD: Control Center	**32**
Views of Earth		CD: Space Ship	**33**
Lunar Surface Images		CD: Control Center/window	**34**
- Dropping a Feather/Hammer - Golfing on the Moon		CD: Control Center/Moon Videos	**35**
- Photosynthesis & Life Support - What is a CELSS[1]? - Recycling in the Lunar Base - Control Overview (optional) - Selection Criteria (optional)		CD: Space Ship/Introductory Readings	**8**
Earth contact videos - Greetings from LMLSTP - BioPLEX is Exciting		CD: Control Center/Monitor to the right of the BaBS screen	**14**
Lab Overview		CD: Laboratory/Lab Information	**62**
Human Requirements Overview		CD: Laboratory/Human Requirements Investigations	**54**
Plant Production Overview		CD: Laboratory/Plant Production Investigations	**53**
Resource Recycling Overview		CD: Laboratory/Resource Recycling Investigations	**55**
- Lab Report Form - Lab Report Form - Guide - What is a Hypothesis? - What is a Variable?		CD: Laboratory/Reference Documents	**64**
Sample Lab Report Form		CD: For Teachers /Assessment Materials	**-**
Sample Research Journal		CD: For Teachers /Assessment Materials	**-**
How Scientists Use Models		CD: Laboratory/Models	**71**

[1] CELSS is an acronym for Controlled Ecological Life Support System. Another more current acronym also used by NASA Advanced Life Support (ALS) research is BLiSS (Bioregenerative Life Support System).

Research Phase: Events 11 - 25

Using advanced simulation software, students complete design and test their own bioregenerative life support system. Their goal is to build a system that will keep their crew of six alive and well for three years without re-supply.

• Introductory Resources

Material	*Type*	*Location*	*Hot Spot #*
Sample Student Research Paper		CD: Laboratory/Reference Documents	**64**
Share Student Research Papers		http://www.cotf.edu/BioBLAST/	**22**
Ask a NASA Expert		http://www.cotf.edu/BioBLAST/	**22**
Mentor Videos - Recommended Readings		CD: Control Center/Mentor Videos	**18**
Laboratory Equipment		CD: Laboratory/Lab Images	**23**

Materials Available for Human Requirements (HR) Research: Events 11 - 15

Material	*Type*	*Location*	*Hot Spot #*
- Humans Essential to Bliss? - No Meat in the Diet? - Will the Water Be Pure? - Do Humans Drink Gray Water?		CD: Control Center/Mentor Videos	**18**
- BioPLEX Goals - BioPLEX Testing - Food Crops in Space - Human Disease in a BLiSS - LMLSTP - Current Test - LMLSTP - Phase 3 - LMLSTP - Test Objectives		CD; Laboratory/Human Requirements Information	**73**
Laboratory Exercise Facility		CD: Laboratory/Lab Images	**23**
Laboratory Medical Facility		CD: Laboratory/Lab Images	**23**
- Building Materials - LMLSTP Food Prep Area - LMLSTP Bathroom - LMLSTP Laundry - LMLSTP Garden - LMLSTP Shower - LMLSTP Crew Rooms		CD: Crew Quarters/Crew Quarter Items	**76**
- Chamber Pantry - Galley - Refrigerator		CD: Crew Quarters/Galley Information	**40**
- Living on the Moon		CD: Crew Quarters/Mentor Videos	**42**
- Food Processing Research -Food Systems for Plant-based CELSS - Sweets in Space	  	CD: Crew Quarters/Food Processing Information	**43**
- Nutrition in Space - Variety in the Diet - Vegetarian Diet		CD: Crew Quarters/ Cooking Information	**44**
- Galley		CD: Crew Quarters/Cooking Information	**44**

Material	*Type*	*Location*	*Hot Spot #*
- Galley Meal - LMLSTP Pantry			
- Assessing Candidates - Candidate Qualities - Mission Preparation		CD: Crew Quarters/Crew Psychology	**49**
How Much Do You Eat?*		CD: Laboratory/ Human Requirements Investigations	**53**
How Many Calories Do You Use?*		CD: Laboratory/ Human Requirements Investigations	**53**
Are Your Meals Nutritious?*		CD: Laboratory/ Human Requirements Investigations	**53**
How Big Is a Serving?*		CD: Laboratory/Human Requirements Investigations	**53**
T-Test Activity*		CD: Laboratory/ Human Requirements Investigations	**53**
Human Requirements (HR) Simulator		CD: Laboratory/Human Requirements (HR) Simulator	**57**
- HR Challenge #1** - HR Challenge #2**		CD: Human Requirements Simulator	**57**

*A Teacher version of this activity is available in the For Teachers Folder - Spreadsheet Activities

**A Teacher version of this activity is available in the For Teachers Folder - HR Sim Investigations

Materials Available for Plant Production Activities

Material	*Type*	*Location*	*HotSpot #*
- What is Photosynthesis? - Don't Plants Need Soil? - What Do Plants Do? - What is Biomass? - What Is Inedible Biomass?		CD: Control Center/Mentor Videos	**18**
- Crop Selection - Factors Affecting Photosynthesis - Germination in a BLiSS - Hydroponic Growing Trays - Hydroponics in Space - LED's - Pros and Cons - Photosynthesis & Respiration - Photosynthesis Rates - Photosynthesis in a BLiSS - Plants as CO2 Scrubbers - Plants in a BLiSS - Respiration Rates - Salads in a BLiSS - Transpiration Defined		CD:/Laboratory/Plant Production Information	**72**
Plant Production (PP) Research Questions		CD: Laboratory/Plant Production Investigations	**53**
Gibberellic Acid Exp.*		CD: Laboratory/ Plant Production Investigations	**53**
- Gray Water Exp.* - Gray Water Exp. Table		CD: Laboratory/ Plant Production Investigations	**53**
- Light Intensity Exp.* - Light Intensity Exp. Table		CD: Laboratory/ Plant Production Investigations	**53**
- Imbibition Exp.* - Imbibition Exp. Table		CD: Laboratory/ Plant Production Investigations	**53**
- Plant Production (PP) Simulator - PP Challenge 1 - Productivity** - PP Challenge 2 - Food Supply**		CD: Laboratory/Plant Production Simulator	**56**

*A Teacher version of this activity  is available in the For Teachers Folder - Plant Production Experiments

**A Teacher version of this activity  is available in the For Teachers Folder - PP Simulation Investigations

Materials Available for Resource Recycling Research Activities

Material	*Type*	*Location*	*Hot Spot #*
- What is a Bioreactor? - Is Everything Recycled? - Will the Water Be Pure? - What is Gray Water? - Do Humans Drink Gray Water? - Recycling Human Waste?		CD: Control Center/Mentor Videos	**18**
- Biological Recycling - How a Bioreactor Works - Microbes in a Bioreactor - Recycling Inedible Biomass - Recycling Steps - Respiration in Composting - What Happens to Waste		CD: Laboratory/Resource Recycling Information	**74**
Resource Recycling (RR) Research Questions		CD: Laboratory/Resource Recycling Investigations	**55**
Decomposition Column Exp.*		CD: Laboratory/Resource Recycling Investigations	**55**
Decomposition Column Exp. Table		CD: Laboratory/Resource Recycling Investigations	**55**
- Gray Water Exp. * - Gray Water Exp. Table		CD: Laboratory/Resource Recycling Investigations	**55**
- Transpiration Exp.* - Transpiration Exp. Table		CD: Laboratory/RR Resource Recycling Investigations	**55**
- Resource Recycling (HR) Simulator -RR Challenge 1- Retention Time** -RR Challenge2-Inedible Biomass** - RR Challenge 3 - Liquid Waste** - RR Challenge 4 - Harvest Cycle** - RR Challenge 5 - Incinerator**		CD: Laboratory/Resource Recycling Monitor	**58**

*A Teacher version of this activity  is available in the For Teachers Folder - Resource Recycling Experiments

**A Teacher version of this activity  is available in the For Teachers Folder - RR Simulation Investigations

Mission Phase: Events 25 - 30

· Students complete their research and ultimately, design and test their own bioregenerative system that will support their crew of six for three years without re-supply.

Materials Available to Accompany the Build a BLiSS Simulator (BaBS)

Material Title	*Type*	*Location*	*Hot Spot #*
BaBS Simulator		CD: Control Center/	**17**
- What is a Closed System? - Is Earth a Closed System? - What is BLiSS? - Components of a BLiSS? - Is Earth a BLiSS? - BaBS Top Ten Tips		CD: Control Center/Mentor Videos	**18**
Control Center Monitoring		CD: Control Center above doorway	**22**
Control Center Outside View		CD: Control Center window	**22**
Control Center Access to Internet		CD: Control Center NASA monitor	**22**
BaBS QuickStart		CD: Control Center	**18**
BaBS References		CD: Control Center	**18**
BaBS Worksheet		CD: For Teachers folder/BaBS	**-**
Assessing BaBS Runs*		CD: Control Center/	**18**

*A Teacher version of this activity  is available in the For Teachers Folder - BaBS folder.

Reporting Phase: Events 31 - 35

- Students demonstrate their knowledge of the scientific process in their final reports and presentations of their research projects. In this phase, we encourage teachers to help students share their research findings within and across schools.

Material Title	*Type*	*Location*	*Hot Spot #*
Student Research Reports		http://www.cotf.edu/BioBLAST/	
Student Lab Reports		http://www.cotf.edu/BioBLAST/	
Teacher Reports		http://www.cotf.edu/BioBLAST/	
Project Updates and Reports		http://www.cotf.edu/BioBLAST/	
- Lab Report Form - Lab Report Form - Guide		CD: Laboratory/Reference Documents	**64**
Sample Lab Report Form		CD: Laboratory/Reference Documents	**64**
Sample Research Journal		CD: Sample pages in Journal in *BioBLAST* program	-

Posttest: Event 35

Teachers distribute the *BioBLAST* posttest at the conclusion of student activities.

Material Title	*Type*	*Location*
Posttest		CD: For Teachers Folder /Assessment Materials
Pre/Posttest Scoring Rubric		http://www.cotf.edu/BioBLAST
Summary of results		http://www.cotf.edu/BioBLAST