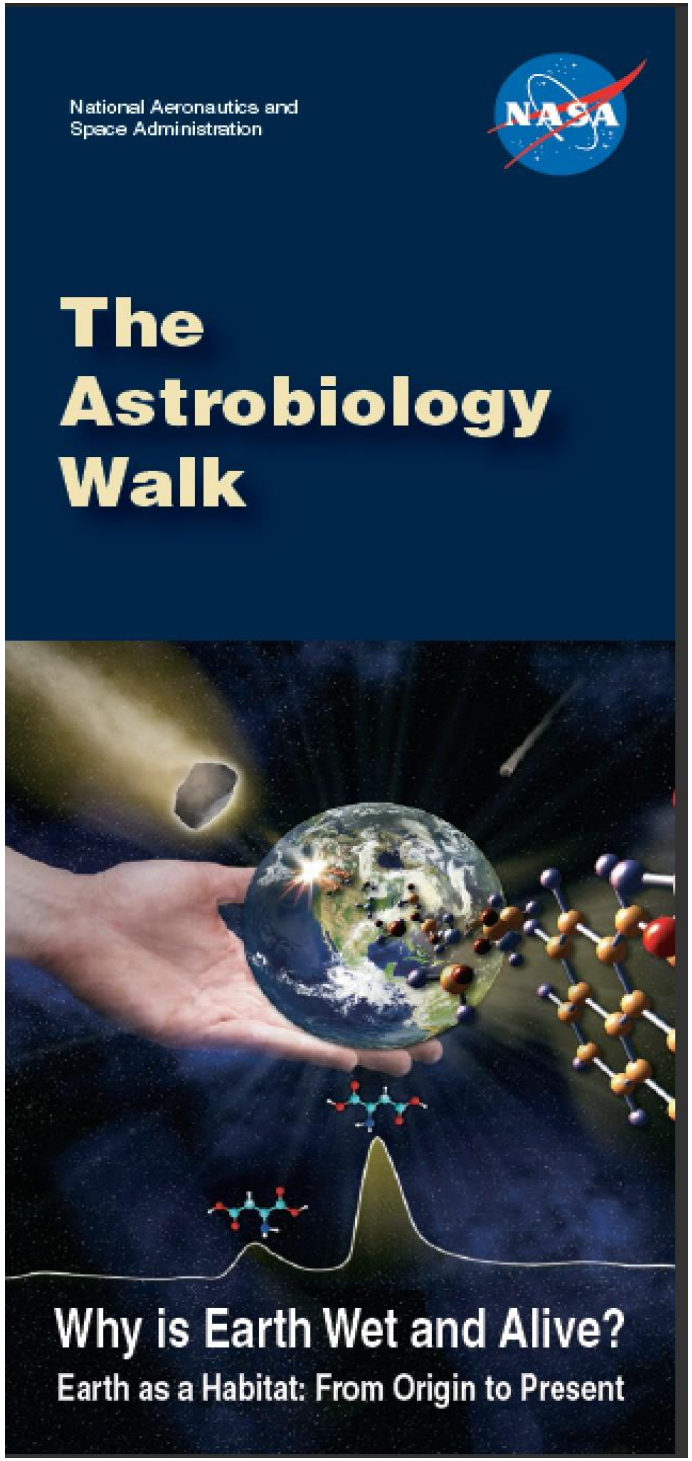

Educator Resource Guide

Draft v.3

10 November 2014

Goddard Center for Astrobiology

http://astrobiology.gsfc.nasa.gov
http://astrobiowalk.gsfc.nasa.gov

About the Guide

Astrobiology is the study of the origin, evolution, distribution, and future of life in the Universe. Astrobiology is an all-encompassing field that requires a multidisciplinary approach involving astronomy, biology, chemistry, geology and physics. The scientists themselves have produced a plethora of materials that educators can use to teach their students about the latest scientific discoveries. This includes the Astrobiology Walk developed by the Goddard Center for Astrobiology. However, these materials often go unused because educators are not familiar with them or do not know how to access them. With the advent of digital technology and the availability of Internet to many school districts, most of the materials are now available online.

This annotated guide is designed to highlight multimedia educational resources on the web that are potentially useful for classroom instruction and learning. The resources are compiled according to the topics in the Astrobiology Walk station placards and seek to provide a more in-depth treatment of the scientific topics.

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Astrobiology Walk Placards: http://astrobiowalk.gsfc.nasa.gov/images/AstroBioPlacards.pdf
Astrobiology Walk Trifold Brochure: http://astrobiowalk.gsfc.nasa.gov/images/AstroBioBrochure.pdf

Station 1A. Earth as a Habitat - From Origin to Present

Water and Life

WEBSITES:

What makes Earth special compared to other planets?
http://www.space.com/5595-earth-special-compared-planets.html
How much water is on Earth?
http://ga.water.usgs.gov/edu/gallery/global-water-volume.html
Water Cycle on Earth
http://science.nasa.gov/earth-science/oceanography/ocean-earth-system/ocean-water-cycle/
Water beyond our Planet
http://science1.nasa.gov/earth-science/oceanography/beyond-our-planet/

LESSON PLANS:

Water Education for Teachers (WET) Lesson Plans (Grades 3-6)
http://www.projectwet.org/teach-and-learn/lesson-plans
EPA Water Science and Technology For Students and Educators (Grades 1-12)
http://water.epa.gov/learn/resources/
How Wet is Our Planet? (Grades 3-12)
https://www.educationoutside.org/lesson-pathway/ecology-b/how-wet-our-planet
Drop in the Bucket
http://ndep.nv.gov/edu/docs/bucket.pdf

Life on Earth and Elsewhere:

WEBSITES:

Timeline of Evolution of Life on Earth
http://exploringorigins.org/timeline.html
What is DNA?
http://ghr.nlm.nih.gov/handbook/basics/dna
What is a cell?
http://ghr.nlm.nih.gov/handbook/basics/cell
Genetic Code (GeneED)
http://geneed.nlm.nih.gov/topic_subtopic.php?tid=15&sid=19
Three Domains of Life
http://www.ucmp.berkeley.edu/alllife/threedomains.html

LESSON PLANS: (PDF download)

The Astrobiology Educator Resource Guide (produced by the NASA Astrobiology Institute in 2007) contains inquiry- and standards-based classroom activities for grades 5-8 and math extensions
http://astrobiology.nasa.gov/media/medialibrary/2013/10/Astrobiology-Educator-Guide-2007.pdf

Station 1B. The Cosmic Progression Towards Life

The Cosmic Progression Towards Life:

WEBSITES:

Big Bang Theory (Universe 101):
http://wmap.gsfc.nasa.gov/universe/
Timeline of the Universe (image download)
http://wmap.gsfc.nasa.gov/media/060915/index.html
Big Bang:
http://www.cfa.harvard.edu/seuforum/bb_popup_history1.htm
Cosmology Tutorial
http://www.astro.ucla.edu/%7ewright/cosmolog.htm

A Cosmic Timeline Towards Life:

WEBSITES:

History of Life on Earth
http://www.bbc.co.uk/nature/history_of_the_earth
Cosmic Journey: A History of Scientific Cosmology
http://www.aip.org/history/cosmology/ideas/start-of-scientific-cosmology.htm
The clock of Eras
http://www.fossils-facts-and-finds.com/clock_of_eras.html

CLASSROOM ACTIVITIES:

Astrobiology -- Are We Alone in the Universe? Got Life?
http://solarsystem.nasa.gov/yss/display.cfm?Year=2012&Month=7
Evolution of Solar System
http://www.lpi.usra.edu/education/timeline/activity/

Station 2A. The Cosmic Cycle of Matter

WEBSITES:

Life and Death of Stars:
http://map.gsfc.nasa.gov/universe/rel_stars.html
Nucleosynthesis in the Early Universe
http://map.gsfc.nasa.gov/universe/bb_tests_ele.html
End of the Dark Ages: First Light
http://www.jwst.nasa.gov/firstlight.html
How elements are made
http://www.universetoday.com/51797/nucleosynthesis/
How elements are formed in a star?
http://www.brighthub.com/science/space/articles/108157.aspx

Some Elements are Older than Others

Web Elements: Essential data and description of the elements in the Periodic Table
http://www.webelements.com/
Chem4kids.com http://www.chem4kids.com/files/elem_intro.html
Periodic Table of the Elements, in Pictures
http://universe-review.ca/I13-01-periodictable2.jpg
Elements in the human body by atomic number
http://chemistry.about.com/od/periodictableelements/ig/Elements-in-the-Human-Body/
How many atoms are in the human body:
http://www.foresight.org/Nanomedicine/Ch03_1.html
http://education.jlab.org/qa/mathatom_04.html
Composition of the human body by mass
http://en.wikipedia.org/wiki/Composition_of_the_human_body
Comparison with the Earth's crust:
http://ecc.pima.edu/~rdwesley/Chapters/LecturesLec4andCH8/lect6fig113.jpg

CLASSROOM ACTIVITIES:

A Universe Without Supernovae: http://www.oercommons.org/courses/a-universe-without-supernovae/view
(Students discover that all elements on Earth and all its living things are made in stars that go supernova.)

VIDEOS:

Origins of Life and Cosmos (Carl Sagan)
http://www.youtube.com/watch?v=kTAjQDatyoY
Composition of human body (Wiki article, with audio ~7.5 min):
http://www.youtube.com/watch?v=ifjp1O1ER0w

Station 2B. From Atoms to Molecules

WEBSITES:

What molecules have we detected in Space?
http://science.gsfc.nasa.gov/691/cosmicice/interstellar.html
Goddard Cosmic Ice Lab: Studying Chemistry in Space
http://science.gsfc.nasa.gov/691/cosmicice/research.html
http://www.nasa.gov/topics/universe/features/cosmic-ice.html
Astronomy Picture Of the Day: Dark Bok Globules in IC 2944:
http://apod.nasa.gov/apod/ap951006.html
Journey inside a Bob Globule:
http://www.universetoday.com/24499/journey-inside-a-bok-globule/

VIDEOS:

Meet GCA Scientists: Reggie Hudson and Perry Gerakines (2 min)
http://www.youtube.com/watch?v=NswyD9q36oU
A horse of different color (video)
http://www.youtube.com/watch?feature=player_embedded&v=LL5L4VFgkdo

We Study Chemistry in Space

The Multiwavelength Universe:
http://imagine.gsfc.nasa.gov/docs/science/know_l1/multiwavelength.html
Cool Cosmos: What is Infrared?
http://coolcosmos.ipac.caltech.edu/page/what_is_infrared
Infrared Astronomy: More than Our Eyes Can See (pdf)
http://www.sofia.usra.edu/Edu/docs/InfraredAstronomy.pdf
What molecules can we detect in the Infrared?
http://en.wikiversity.org/wiki/Infrared_astronomy
W.M. Keck Observatory
http://www.keckobservatory.org/fans
Atacama Large Millimeter Array
http://www.almaobservatory.org/en/visuals
Hubble Space Telescope
http://hubblesite.org/
Stratospheric Observatory for Infrared Astronomy
http://www.sofia.usra.edu/Sofia/science/sofia_sci.html

LESSON PLANS:

Spectra from Space: http://cse.ssl.berkeley.edu/SegwayEd/lessons/spectra_fr_space/index.htm

Station 3A. Protostellar 'Factories' Churn Out Chemicals

From Molecular Cores to Planets

WEBSITES:

What is Astrochemistry?
http://www.wisegeek.com/what-is-astrochemistry.htm
GCA Research: From Molecular Cores to Planets
http://astrobiology.gsfc.nasa.gov/research2.html
Spitzer Captures Cosmic Mountain of Creation:
http://www.nasa.gov/vision/universe/starsgalaxies/spitzer-20051109.html
The Birth of Stars and Protoplanetary Systems
http://jwst.nasa.gov/birth.html

Hot and Cold Chemistry

WEBSITES:

Star Forming region imaged by HST – NGC 3324 in the Carina Nebula
http://hubblesite.org/newscenter/archive/releases/nebula/2008/34/
Young Stars Surrounded by Disks of Dust (HST image of HH30)
http://hubblesite.org/newscenter/archive/releases/1999/05/image/c/

Astrochemistry & Astrobiology (S. Charnley 9.5 MB presentation)
http://www.astro.iag.usp.br/xiieaa/Steven/Charnley_1.pdf

Station 3B. The Importance of Space Dust

VIDEOS:

Meet GCA scientist – Dr. Joseph Nuth:
http://svs.gsfc.nasa.gov/vis/a010000/a010600/a010615/joe_nuth_nasacast.m4v
Dust Models Paint Alien's View of Solar System
http://www.nasa.gov/topics/solarsystem/features/dust-model.html
Planetary Formation
http://www.youtube.com/watch?v=L2d7joOgVLg

WEBSITES:

Twin Keck Telescopes Probe Dual Dust Disks
http://www.nasa.gov/centers/goddard/news/topstory/2009/dust_disks.html
JSC Cosmic Dust Laboratory
http://curator.jsc.nasa.gov/dust/

A Planetary System is Born

WEBSITES:

Birth of Worlds
http://solarsystem.nasa.gov/yss/display.cfm?ThemeID=2&Tab=Background
From Dust to Planets
http://www.mnh.si.edu/earth/text/5_3_1_0.html
How to Make a Planet
http://www.mnh.si.edu/earth/text/5_1_4_0.html

Station 4A. Formation of the Earth and its Moon

WEBSITES:

Origin of the Earth and Moon:
http://solarsystem.nasa.gov/scitech/display.cfm?ST_ID=446
Solar System Exploration: Earth's Moon: 10 Need-to-Know Things about the Moon
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Moon
FAQ: http://solarsystem.nasa.gov/planets/profile.cfm?Object=Moon&Display=FAQ

Newly Formed Earth was Hot

WEBSITES:

Zircon and Early Surface Water on Earth
http://www.nsf.gov/od/lpa/news/press/01/pr0102.htm
The Hadean
http://paleobiology.si.edu/geotime/main/hadean1.html

VIDEOS:

Cosmic Journeys: Birth of the Moon (24:26 min)
http://www.youtube.com/watch?v=WGTBJHFNywI

If we had no Moon (video series):
Part 1: The Earth-Moon System (10 min): http://www.youtube.com/watch?v=wW_vmnfTeWM
Parts 2 to 5 (10 min each): http://www.youtube.com/watch?v=acu2zs5fKoo&list=PL004C21A96B2E5E96
Part 2: Moon-forming impact: (10 min): http://www.youtube.com/watch?v=acu2zs5fKoo
Part 3: Effect of the Moon on Earth (10 min): http://www.youtube.com/watch?v=D8fKubr1wro
Part 4: Effect of Moon on Emergence of Life on Earth (10 min): http://www.youtube.com/watch?v=S53nLob2SoM
Part 5: Exploration of the Moon (10 min): http://www.youtube.com/watch?v=qVmdjkekAJo

Station 4B. Missing: Record of Earth's Early History

Large Impact Craters

WEBSITES:

Impacts!
http://solarsystem.nasa.gov/yss/display.cfm?ThemeID=25&Tab=Background
Science Resources of the IOMN
http://observethemoonnight.org/resources/
Impact Craters on the Moon:
http://www.enchantedlearning.com/subjects/astronomy/moon/Craters.shtml
Anatomy of an Impact:
http://www.mnh.si.edu/earth/text/5_3_2_0.html
LRO mission sheds light on early solar system
http://physicsworld.com/cws/article/news/2010/sep/21/lunar-mission-sheds-light-on-early-solar-system
LRO Creating Unprecedented Topographic Map of Moon
http://www.nasa.gov/mission_pages/LRO/news/lola-topo-map.html
Moon Rocks Led to New Insights in Early Solar System:
http://www.voanews.com/content/a-13-2009-07-15-voa15-68745027/410250.html
Apollo 15 and the Genesis rock:
http://www.nasa.gov/centers/johnson/home/0812_history_milestone.html
Lunar Reconnaissance Orbiter Camera (LROC) Images
http://lroc.sese.asu.edu/news/index.php?/categories/2-Featured-Image

VIDEOS:

LRO: Animation of the evolution of the Moon:
http://www.youtube.com/watch?v=2msFzwil5HM
Moon from LRO : http://www.youtube.com/watch?v=sNUNB6CMnE8
Description: http://www.nydailynews.com/news/world/nasa-moons-earthlings-revealing-video-article-1.1458922

Teacher's Guide on Impact Craters (PDF download):
http://www.nasa.gov/pdf/180572main_ETM.Impact.Craters.pdf

Station 5A. Building a Wet and Habitable Earth

WEBSITES:

The Shocking Source for Life's Origins:
http://www.astrobio.net/pressrelease/5646/the-shocking-source-for-lifes-origins

How did the oceans form?
http://www.amnh.org/learn/ocean/Resource1

History of the Earth:
http://en.wikipedia.org/wiki/History_of_the_Earth#Oceans_and_atmosphere

Solar System Exploration: Earth FAQ
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Earth&Display=FAQ

10 things to know about Earth:
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Earth

CLASSROOM ACTIVITIES:

Properties of Matter (Activities and Lesson Plans from AstroVenture):
http://astroventure.arc.nasa.gov/teachers/pdf/AV-Astronolesson-Part2.pdf

Design a Planet (Interactive modules from AstroVenture):
http://www.oercommons.org/courses/astro-venture-astronomy-educator-s-guide/view

Station 5B. Rearranging our Planetary System

VIDEOS:

Meet the Scientist: Dr. Hal Levison (interview):
http://solarsystem.nasa.gov/people/profile.cfm?Code=LevisonH
Dr. Hal Levison on Planetary Migration (YouTube):
http://www.youtube.com/watch?v=KXs_fccVKmQ

The Late Heavy Bombardment (BBC video ~4 min)
http://www.bbc.co.uk/science/earth/earth_timeline/late_heavy_bombardment#p006x4v3
Unsettled Young: A Chaotic Planetary System (3.52 min)
http://www.spitzer.caltech.edu/video-audio/1322-SpitzerAudio-053-Unsettled-Youth-A-Chaotic-Planetary-System?autoplay=true&limit=20

WEBSITES:

Kuiper Belt and Oort Cloud:
http://solarsystem.nasa.gov/planets/profile.cfm?Object=KBOs

'Fairy Tale' might explain moon craters and planet orbits
http://www.space.com/1130-fairy-tale-explain-moon-craters-planet-orbits.html

Roaming Giants: Did migrating planets shape the solar system?
http://www.phschool.com/science/science_news/articles/roaming_giants.html

Solar System History Rewritten: (on planetary migration)
http://moonandback.com/2013/03/25/solar-system-history-rewritten-as-science-links-moon-vesta/

Uranus, Neptune, and the Mountains of the Moon:
http://www.psrd.hawaii.edu/Aug01/bombardment.html

Asteroid and Comet Impact Hazards:
http://impact.arc.nasa.gov/intro_faq.cfm

CLASSROOM ACTIVITIES:

Studying Planet Orbital Paths (Grade 6-7):
http://www.oercommons.org/courses/planet-paths-studying-planetary-orbital-paths/
Studying the Movement of Celestial Objects (Grade K-4):
http://www.oercommons.org/courses/sky-paths-studying-the-movement-celestial-objects/

Station 6A. Messengers from the Early Solar System

WEBSITES:

Small Worlds, Big Discoveries
http://solarsystem.nasa.gov/smallworlds/about.cfm
Asteroids: http://solarsystem.nasa.gov/smallworlds/asteroids.cfm
http://solarsystem.nasa.gov/yss/display.cfm?ThemeID=26
Asteroid fact sheet:
http://nssdc.gsfc.nasa.gov/planetary/factsheet/asteroidfact.html
NSSDC asteroid page:
http://nssdc.gsfc.nasa.gov/planetary/planets/asteroidpage.html

What is the difference between comets and asteroid?
http://earthsky.org/space/whats-the-difference-between-comets-and-asteroids

Comet Fact Sheet: http://nssdc.gsfc.nasa.gov/planetary/factsheet/cometfact.html

Comets: http://solarsystem.nasa.gov/smallworlds/comets.cfm
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Comets

Recent NASA Missions to Comets:
http://solarsystem.nasa.gov/yss/display.cfm?ThemeID=21&Tab=Featured%20Missions

Deep Impact: http://www.nasa.gov/mission_pages/deepimpact/main/index.html#.UjyFPLwf8_7
EPOXI: http://www.nasa.gov/mission_pages/epoxi/#.UjyFfLwf8_4
Stardust: http://stardust.jpl.nasa.gov/home/index.html

Meet GCA Scientist: Professor Michael A'Hearn:
http://deepimpact.umd.edu/mission/bios/bio-mahearn-umd.html

CLASSROOM ACTIVITIES:

Discovery Kids Interactive Quiz: Comet, Asteroid, or Meteor?
http://discoverykids.com/games/asteroid-comet-or-meteor-quiz/

Station 6B. Cometary Compositions Reflect Diverse Origins

WEBSITES:

Small Bodies, Big Impacts:
http://solarsystem.nasa.gov/yss/display.cfm?Year=2011&Month=2

Small Bodies of the Solar System
http://science1.nasa.gov/planetary-science/focus-areas/small-bodies-of-the-solar-system/

Comets: http://solarsystem.nasa.gov/smallworlds/comets.cfm

Comet fact sheet:
http://nssdc.gsfc.nasa.gov/planetary/factsheet/cometfact.html
http://amazing-space.stsci.edu/resources/explorations/cometmyth/home.html

Comet Shoemaker-Levy: Collision with Jupiter, July 1994
http://en.wikipedia.org/wiki/Comet_Shoemaker%E2%80%93Levy_9

Comet Hartley 2 Revealed Water Ice Similar in Chemical Composition to Earth's Oceans:
http://ww.dailygalaxy.com/my_weblog/2013/08/-origins-comet-hartley-2-revealed-water-ice-similar-in-chemical-composition-to-earths-oceans.html

Comet Siding Spring: Close flyby of Mars, October 2014
http://newswatch.nationalgeographic.com/2013/03/06/monster-comet-may-have-mars-in-its-crosshairs/

The Cosmic Ice Lab: Cometary molecules:
http://science.gsfc.nasa.gov/691/cosmicice/cometary.html

VIDEOS:

How to make a comet (using art supplies):
http://www.jpl.nasa.gov/education/videos/playVideo.cfm?videoID=16

CLASSROOM ACTIVITIES:

Making a Comet in the Classroom:
http://www.noao.edu/education/crecipe.html

NeoK12 Comets for Kids:
http://www.neok12.com/Comets.htm

Lesson Plans:

Comets: http://amazing-space.stsci.edu/resources/explorations/comets/teacher/lessonplan.html

Free Comet Activities, Handouts, Powerpoint, Interactives: http://science.lotsoflessons.com/space/comets.html

The Impact of Shoemaker-Levy 9; http://www.smplanet.com/teaching/science/science

The Comet's Tale: http://cse.ssl.berkeley.edu/SegwayEd/lessons/CometsTale/com.html

Station 7A. Meteorites Contain Ingredients for Life

WEBSITES:

10 Need-to-Know Things About Meteors and Meteorites
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Meteors
What are meteorites?
http://www.meteorlab.com/METEORLAB2001dev/whatmeteorites.htm
Wishing on a Meteorite! (For kids)
http://www.kidsastronomy.com/meteorites.htm
Analysis of Complex Organics at GCA
http://astrobiology.gsfc.nasa.gov/research3.html

The Antarctic Search for Meteorites (ANSMET)
http://artscilabs.case.edu/ansmet/
Martian meteorites: http://en.wikipedia.org/wiki/Mars_meteorite
Meteor Shower Guide:
http://earthsky.org/astronomy-essentials/earthskys-meteor-shower-guide
Meteorite Gallery at the Smithsonian Museum of Natural History
http://geogallery.si.edu/index.php/en/meteorites
Arthur Ross Hall of Meteorites at the American Museum of Natural History
http://www.amnh.org/exhibitions/permanent-exhibitions/earth-and-planetary-sciences-halls/arthur-ross-hall-of-meteorites

VIDEOS:

Meet the scientist – Dr. Daniel Glavin:
http://svs.gsfc.nasa.gov/vis/a010000/a010600/a010615/danny_glavin_svs.mpg
Meet the scientist – Dr. Michael Callahan:
http://svs.gsfc.nasa.gov/vis/a010000/a010800/a010810/dna_building_blocks_web_short_nasacast.mp4

CLASSROOM ACTIVITIES:

Searching for Meteorites:
http://dawn.jpl.nasa.gov/news/pdf/Searching_For_Meteorites.pdf

Station 7B. Mirror-Image Molecules; Left-Handed Life

WEBSITES:

Left-handed life:
http://www.nasa.gov/centers/goddard/news/topstory/2009/left_hand_life.html

Life's Building Block in Comet Wild-2:
http://www.nasa.gov/mission_pages/stardust/news/stardust_amino_acid.html

DNA Building Blocks can be made in Space: (in 7A)
http://www.nasa.gov/topics/solarsystem/features/dna-meteorites.html

OSIRIS-REx Mission: http://osiris-rex.lpl.arizona.edu/
StarDust mission: http://stardustnext.jpl.nasa.gov/

Why go to asteroid Bennu? http://osiris-rex.lpl.arizona.edu/?q=node/54

VIDEOS:

Meet the Scientist – Dr. Jason Dworkin
http://svs.gsfc.nasa.gov/vis/a010000/a010600/a010615/jason_dworkin_svs.mpg

Meet the Scientist – Dr. Jamie Elsila-Cook:
http://svs.gsfc.nasa.gov/vis/a010000/a010600/a010615/jamie_cook_svs.mpg

Station 8A. Life Transformed Earth

WEBSITES:

The Three Domains of Life
http://www.ucmp.berkeley.edu/alllife/threedomains.html

Tree of Life (PDF download):
http://timetree.org/poster/timetree8.5x11.pdf

Archaea, the Bug Next Door?
http://www.astrobio.net/pressrelease/2172/archaea-the-bug-next-door

The rise of oxygen: http://www.astrobio.net/exclusive/541/the-rise-of-oxygen

Banded Iron Formations:
http://en.wikipedia.org/wiki/Banded_iron_formation

The Great Oxidation Event:
http://www.sciencedaily.com/releases/2013/01/130117084856.htm

The Houses that Microbes Build
http://www.astrobio.net/exclusive/5706/the-houses-that-microbes-build

Fossil record of cyanbacteria: http://www.ucmp.berkeley.edu/bacteria/cyanofr.html

Stepping Stones through Time: http://www.astrobio.net/exclusive/3636/stepping-stones-through-time

Living stromatolites in Shark Bay: http://www.sharkbay.org/stromatolites.aspx

VIDEOS:

The Great Oxidation Event (12:32 min.): http://www.youtube.com/watch?v=7gURy-aVTOo

CLASSROOM ACTIVITIES:

The Air We Breathe (Grade K-4): http://teacherlink.ed.usu.edu/tlnasa/units/TheAirWeBreathe/TheAirWeBreathe.pdf

Station 8B. Extremophiles

WEBSITES:

Life's Hot Spot
http://www.astrobio.net/pressrelease/2488/lifes-hot-spot

First Fossil-Makers in Hot Water:
http://www.astrobio.net/exclusive/3418/first-fossil-makers-in-hot-water

"Science of the Springs" guidebook to Yellowstone astrobiology sites
http://abrc.montana.edu/outreach/scienceofthesprings.html

Records of Life in Ice: Opening the Cryogenic Vault
http://astrobiology.com/2008/11/records-of-life-in-ice-opening-the-cryogenic-vault.html
Examining a SLIce of the Arctic
http://www.astrobio.net/pressrelease/2991/examining-a-slice-of-the-arctic-
Amase-ing Life on the Ice
http://www.astrobio.net/index.php?option=com_expedition&task=detail&id=3231

Traces of microbes in shallow ice layers may help find life on icy worlds
http://www.thaindian.com/newsportal/health/traces-of-microbes-in-shallow-ice-layers-may-help-find-life-on-icy-worlds_100209785.html
The Dark Story on Sea-ice Microorganisms
http://www.dfo-mpo.gc.ca/science/publications/article/2009/11-09-09-eng.html
What do we know about organisms that thrive in Arctic sea ice?
http://www.arctic.noaa.gov/essay_krembsdeming.html
NASA Earth Observatory: What are Phytoplankton?
http://earthobservatory.nasa.gov/Features/Phytoplankton/
Teacher's domain: Antarctic Ecosystem
http://www.teachersdomain.org/asset/ipy07_int_antarcticecosys/

VIDEOS:

Meet the scientist: Jen Eigenbrode:
http://women.nasa.gov/jennifer-eigenbrode/

Station 9A. Search for Life in the Solar System

WEBSITES:

Life on Europa?
http://geology.com/stories/13/life-on-europa/
Tiny Submersible Could Search for Life in Europa's Ocean
http://www.astrobio.net/exclusive/5518/tiny-submersible-could-search-for-life-in-europas-ocean

GCA Science: Europa's Hidden Ice Chemistry
http://ww.nasa.gov/topics/solarsystem/features/europa-ice.html
Cassini's mission
http://www.nasa.gov/mission_pages/cassini/main/index.html
Clay-Like Minerals Found on Icy Crust of Europa
http://www.nasa.gov/jpl/news/europa-clay-like-minerals-20131211.html#.UqnXwY2zLro
Cassini Samples the Icy Spray of Enceladus
http://www.esa.int/Our_Activities/Space_Science/Cassini-Huygens/Cassini_samples_the_icy_spray_of_Enceladus_water_plumes
Saturn's moons
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Saturn&Display=Sats
Enceladus
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Sat_Enceladus
Ice Geysers on a Distant Moon
http://www.slate.com/blogs/bad_astronomy/2013/09/26/enceladus_cassini_spacecraft_spots_geysers_of_water.html
Saturn's Enceladus: New Evidence of a Large Body of Water Lurking Under Its Icy Surface
http://www.dailygalaxy.com/my_weblog/2013/07/enceladus-new-evidence-of-an-ocean-lurking-under-its-icy-surface-1-1.html
Breaking Through the Ice at Lake Vostok
http://www.astrobio.net/exclusive/4571/breaking-through-the-ice-at-lake-vostok

VIDEOS:

Antarctic Lake's Ice Harbors Thousands Of Species' DNA (Video, ~2 min)
http://www.huffingtonpost.com/2013/07/09/lake-vostok-life-antarctica-ice-thousands-species-dna_n_3565892.html
Discovery Video: Europa's Living Ocean (~2.5 min)
http://dsc.discovery.com/tv-shows/other-shows/videos/stephen-hawkings-universe-europas-living-ocean.htm
"Nova" Video : Finding Life Beyond Earth (1.8 hr video)
http://www.youtube.com/watch?v=asN3Rgwh1Tk

Station 9B. Search for Life on Mars

VIDEOS:

Meet the scientist: Dr. Michael Mumma
http://svs.gsfc.nasa.gov/vis/a010000/a010600/a010615/mike_mumma_svs.mpg
http://svs.gsfc.nasa.gov/vis/a010000/a010600/a010615/mike_mumma_nasacast.m4v
YouTube lecture of Dr. Michael Mumma at U of Flordia (Nov 4, 2011):
http://www.youtube.com/watch?v=9EyM3FggUDA&list=PLF093A720C85FDCE6&feature=plpp_play_all
Dr. Geronimo Villaneuva (in Spanish):
http://svs.gsfc.nasa.gov/vis/a010000/a010600/a010615/Astrobiology_Geronimo_Villanueva_ENG-SUB_nasacast.m4v
SAM scientist: Dr. Paul Mahaffy
http://svs.gsfc.nasa.gov/vis/a010000/a010200/a010206/Paul_Mahaffy_sound_bites_ipod_sm.mp4
http://www.youtube.com/watch?v=MgVun2V116E&feature=youtube_gdata
Super Volcanoes on Mars (Nature video, ~4.3 min), Get Nature's cover as image button
http://www.scientificamerican.com/video.cfm?id=supervolcanoes-on-mars2013-10-03

WEBSITES:

Methane on Mars:
http://www.nasa.gov/mission_pages/mars/news/marsmethane.html
NASA Rover Scientists Wring Water Story from Rocks
http://en.wikipedia.org/wiki/Water_on_Mars
Water & Organics on Mars (S. Domagal-Goldman):
http://solarsystem.nasa.gov/yss/videos/index.cfm?Filename=YSS_AlienHunters_SDomagalGoldman_DGrinspoon_Aug28_2012_final-3
Mars pages at NSSDC: http://nssdc.gsfc.nasa.gov/planetary/planets/marspage.html
Curiosity website: http://mars.nasa.gov/msl/
All about Mars: http://mars.jpl.nasa.gov/allaboutmars/
Mars May Have Once Been a Cold, Wet World
http://www.universetoday.com/88525/mars-may-have-once-been-a-cold-wet-world/
A Martian Dream: http://www.theatlantic.com/technology/archive/2013/01/a-martian-dream-heres-what-the-red-planet-would-look-like-with-earth-like-oceans-and-life/266791/
SAM and The Astrobiology Analytical Lab:
http://www.nasa.gov/centers/goddard/news/features/2012/astrobio-lab.html
Discoveries by Goddard's Mars Orbiter Laser Altimeter
http://mola.gsfc.nasa.gov/discoveries.html

CLASSROOM ACTIVITIES:

Back-of-the-Envelope Calculations: Communication with Mars:
http://www.oercommons.org/courses/back-of-the-envelope-calculations/view

Station 10A. A Galaxy Full of Diverse Exoplanets

WEBSITES:

Our Planetary Family Tree: http://solarsystem.nasa.gov/yss/display.cfm?ThemeID=3&Tab=Background
Discovering New Worlds: http://solarsystem.nasa.gov/yss/display.cfm?ThemeID=36&Tab=
Methods: http://solarsystem.nasa.gov/yss/display.cfm?ThemeID=36&Tab=Background

Planet Quest: http://planetquest.jpl.nasa.gov
Goldilocks and the Three Planets:
http://www.physics.sdsu.edu/~johnson/writing/climate.html
NASA Exoplanet Archive: http://exoplanetarchive.ipac.caltech.edu
Habitable Zone Gallery: http://www.hzgallery.org
Habitable Exoplanets Catalog: http://phl.upr.edu/projects/habitable-exoplanets-catalog
Open Exoplanet Catalogue: http://www.openexoplanetcatalogue.com

iPhone application: http://exoplanetapp.com

GCA Science: EPOXI Observing Exoplanet Transits
http://www.nasa.gov/centers/goddard/news/topstory/2007/epoxi.html
The Hottest Exoplanet
http://www.astronomy.com/news-observing/news/2007/05/the%20hottest%20exoplanet or
http://spaceflightnow.com/news/n0705/09hotplanet/
Earth as an Exoplanet
http://www.nasa.gov/mission_pages/epoxi/sun-glints.html
Banjo-Playing Drake Deming:
http://www.nasa.gov/centers/goddard/about/people/drake-deming.html

VIDEOS:

How to Hunt for New Earths (Nader Haghighipour):
http://content.time.com/time/video/player/0,32068,2286956635001_2141568,00.html

CLASS ACTIVITIES:

Planetary Temperature Systems (Activities and Lesson Plans for Grade 5-8 in AstroVenture):
http://astroventure.arc.nasa.gov/teachers/pdf/AV-Astronolesson-Part3.pdf

Station 10B. Exploring Exoplanet Atmospheres

WEBSITES:

A Super Time for SuperEarths:
http://www.astrobio.net/exclusive/5664/a-super-time-for-superearths
James Webb Space Telescope:
http://www.jwst.nasa.gov/

VIDEOS:

Five Ways to Find a Planet (interactive): http://planetquest.jpl.nasa.gov/system/interactable/11/index.html
Planetary Studies: JWST
http://www.youtube.com/watch?v=Pp8rUn5Tsos
Exoplanet (wiki article, audio ~44 min):
http://www.youtube.com/watch?v=AF_r3_GDEh4
Exoplanet musical composition:
http://www.youtube.com/watch?v=Z1jrUFtQoO8
Characterizing Exoplanets using JWST (Presention by GCA Scientist: Drake Deming);
http://www.stsci.edu/jwst/doc-archive/presentations/AIAA-sept2011-Deming.pdf
LIFE IN THE UNIVERSE documentary (1:33:12):
http://www.youtube.com/watch?v=34sEX6VM9sU
MARS – the red planet documentary (43:45), including formation of Solar System:
http://www.youtube.com/watch?annotation_id=annotation_310177&feature=iv&src_vid=34sEX6VM9sU&v=Glah07CTS7c

Classroom Activities:

How do we find planets around other stars?
http://www.oercommons.org/courses/how-do-we-find-planets-around-other-stars/view
A Case of the Wobbles: Finding Extra Solar Planets
https://www.oercommons.org/courses/a-case-of-the-wobbles-finding-extra-solar-planets
Space Math: The Earth-like Planet Gliese 518g:
https://www.oercommons.org/courses/space-math-the-earth-like-planet-gliese-518g