5 RED PLANET and QUEST

SYNOPSIS

RED PLANET – Mars
Mars, the red planet, is the world on which next we will walk. The Martian day is a comfortable 24-and-a-half hours. But the rest is strange – planet-wide duststorms, overnight temperatures below minus 100 degrees Celsius and a daytime high just above freezing. Mars has the biggest volcano in the Solar System, Olympus Mons, and the largest geological fault, Mariner Valley. Water once flowed on this arid planet. Possibly, there was life. So what happened?

QUEST – Search for Extra Terrestrial Life
Earth is perfect for life. Venus is too close to the Sun and Mars too distant. The only other possibility in the Solar System is Europa, a moon of Jupiter. There, in an ocean beneath Europa's icy surface, bacteria-like organisms could feed on volcanic vents. But the best chance of life is on Earth-like planets around other stars. Too small to be seen by present-day instruments, the new Terrestrial Planet Finder may spy them from Earth orbit.

BACKGROUND

Mars is 228-million kilometres from the Sun – the fourth planet out. One orbit of the Sun takes 687 days, so a Martian year is almost twice as long as Earth's. With a diameter of less than 6,800 kilometres, Mars is little over half the size of Earth and one-ninth its mass. Both have similar axial tilts. To us, the Martian day is a comfortable 24.5 hours.

The weather is not so comfortable. From temperatures approaching minus 100 degrees Celsius before dawn, frost and mist disperse in the morning. The sky is pink with Martian dust. Winds are light and variable and the tenuous atmosphere unbreathable. At midday it's fine and clear with an afternoon high of just above freezing. But as sunset approaches, ice clouds appear and temperatures plummet.

Mars is the world on which next we will walk. The north, smoothed by the flow of lava plains, has the younger surface. The south is heavily cratered from old impacts. Between the two is Mariner Valley. The largest geological fault in the Solar System, Mariner would stretch across the USA. At a maximum seven kilometres deep and 600 wide, it is the grandest grand canyon.

West of Mariner are the three huge volcanoes of the Tharsis Ridge. Still farther west is Olympus Mons, the greatest volcano in the Solar System, three times as high as Everest. From the surrounding terrain, Olympus Mons rises 25 kilometres. Its base is as wide as the state of Colorado.

Volcanic activity probably made early Mars much warmer and wetter than today. A great sea, called Oceanus Borealis, could have filled much of the northern hemisphere. Volcanic gases may have thickened the atmosphere, sending

temperatures soaring. It most likely rained. As eruptions melted sub-surface ice, Mars could have flowed with water. There is no shortage of topographical evidence.

Why did the water disappear? Volcanic shut-down may have been the cause. Eruptions no longer replenished the atmosphere. Most of it leaked into space, due to weak gravity. The seas ran dry. Residual water froze beneath the surface.

Mars is now a freezing waste, the only visible water being the polar ice caps. As on Earth, they grow in winter and recede in summer. Most of Mars is a dusty desert – red, due to iron oxide. Periodically, duststorms kick up. They can blanket the planet and last for weeks.

Since life depends on it, evidence of water remains the greatest quest. Currently probes map the planet and continue the search for water – and life. In 2003 one robot lander confirmed there had once been water. Indeed, if Mars were warmer there would be no shortage. Scientists believe the planet would flood to a depth of ten metres if the icecaps melted!

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Unlike Mars, Earth abounds with water. Two-thirds of our surface is ocean. Since it arose, life has teemed in the depths – an incubator of evolution. Life crawled ashore, grew wings and conquered the air. Reptiles, plants and insects filled every niche. Mammals evolved and eventually humankind. But so far – and the hunt is on – we've found life only on Earth.

Yet life comes from the stars. Supernovae, the explosive death of gigantic stars, spew debris through space - debris rich in heavy elements like carbon and iron, elements vital to all living cells. A supernova triggered the formation of the Solar System. But of the nine planets seeded from that ancient blast, only one would blossom – Earth.

Not until Earth cooled some 3.8-billion years ago did those seeds stand a chance. Oceans formed from the water vapour of volcanic eruptions and from the ice of incoming comets. Earth bubbled gases from the interior to form a poisonous atmosphere of nitrogen and carbon dioxide.

Did life reach us on a comet? Or was lightning the catalyst? And where did life catch hold? Possibly in volcanic hot springs, rich in nutritious chemicals. Fossils suggest single-cell organisms - prokaryotes - began there. Other evidence indicates they clustered round "smokers" deep in the oceans. But they were tied there. Only when they photosynthesised, using sunlight, did they go green and colonise the world.

By releasing oxygen, photosynthesis changed the atmosphere. A protective ozone layer developed and oceans had the first oxygen-breathing cells. They became multi-cellular. Sexual reproduction began. Life exploded and diversified. Such a blooming is thanks to Earth's position in the Solar System – third planet from the Sun.

We orbit in the middle of the habitable zone. Mars and Venus are at the edges. Life may have tried on Venus but cloud conceals a pressure-cooker where nothing can survive. Venus is too close to the Sun. And Mars is too far. If volcanic activity

made early Mars warmer and wetter, life, at best, would have been microbial. Today it is just too cold and dry.

The only other possibility of life in the Solar System is on Jupiter's moon Europa. Sheet-ice covers the whole surface. Beneath, however, is thought to be a vast ocean. Disruption of the surface ice hints at volcanic vents spouting on the ocean floor. Around them, feeding on their chemical nutrients, simple life could thrive – bacteria-like organisms deep in a sunless sea.

Beyond Jupiter, it is just too cold for life. So we must look to the stars. Lots of astronomers believe planet formation is a natural by-product of star formation. Many extrasolar planets as big as Jupiter have already been detected (plus a few smaller ones) – but they are too hostile for life. Not until we spy small rocky planets like Earth can we hope to detect life. For that we await the launch of the Terrestrial Planet Finder. From Earth orbit, this highly sensitive instrument will scan the habitable zones around stars for benign little worlds where life may flourish.

Until then, we are all alone in the Cosmos.

Weblinks for RED PLANET

http://en.wikipedia.org/wiki/Mars and
http://en.wikipedia.org/wiki/Exploration_of_Mars - From Wikipedia, the free encyclopedia, two websites covering the atmosphere, geology and geography of Mars. Also covered: the orbital characteristics of Mars, its tiny moons, life on Mars, Mars in fiction and the exploration of Mars.

http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level1/mars.html - From the "StarChild" service at NASA's Goddard Space Flight Center, an introduction to Mars written for young people. Information available at two levels.

http://www.dustbunny.com/afk/planets/mars/ - From the "Astronomy for Kids" website, a handy summary of Mars.

http://nssdc.gsfc.nasa.gov/planetary/factsheet/marsfact.html - NASA's Mars fact sheet.

http://marsprogram.jpl.nasa.gov/funzone_flash.html - From NASA's Mars Exploration Program, Mars for Kids incorporating fun, games and activities relating to the red planet.

http://marsprogram.jpl.nasa.gov/classroom/students.html - From NASA's Mars Exploration Program, Mars for Students, including Homework Help, Talk to Scientists, Build a Mars Spacecraft and much more.

http://marsprogram.jpl.nasa.gov/classroom/ - From NASA's Mars Exploration Program, Mars for Educators, with details of Mars Educator workshops, Mars Classroom Resources and Activities, and Mars Education Programs.

http://www.windows.ucar.edu/tour/link=/mars/mars.html&edu=high - From the University Corporation for Atmospheric Research's "Windows to the Universe" website, a comprehensive guide to Mars with information available at beginner, intermediate and advanced levels.

http://photojournal.jpl.nasa.gov/targetFamily/Mars - NASA's image access page for a wide range of images of Mars and its moons.

http://www.google.com/mars/ - Have fun exploring Mars for yourself! In collaboration with NASA researchers at Arizona State University, Google has created some of the most detailed scientific maps of Mars ever produced. Includes three different types of maps - elevation, visible and infrared.

http://mars.jpl.nasa.gov/ - NASA's Mars missions home page with news and updates on all the currently operational Mars space missions.

http://www.msss.com/moc_gallery/index.html - Welcome to the Mars Orbiter Camera (MOC) Image Gallery! This site contains all of the pictures of Mars acquired by NASA's Mars Global Surveyor (MGS) orbiter through September 2005. Contains more than 212,000 images!

http://www.esa.int/SPECIALS/Mars_Express/index.html - All the latest updates, images, and videos from the European Space Agency's Mars Express mission, now in orbit around the Red Planet.

http://marsrovers.nasa.gov/home/ - News, press releases, images and videos from Spirit and Opportunity, the two Mars Exploration Rovers.

http://marsprogram.jpl.nasa.gov/mro/ - From NASA's Jet Propulsion Laboratory, the Mars Reconnaissance orbiter home page. News and information from NASA's latest space mission to the red planet.

Weblinks for QUEST

http://en.wikipedia.org/wiki/Extraterrestrial_life - From Wikipedia, the free encyclopedia, a comprehensive summary of the scientific search for extraterrestrial life being carried out directly and indirectly.

http://curious.astro.cornell.edu/seti.php - From the "Ask an Astronomer" site at Cornell University a good summary of the Search for Extra-Terrestrial Intelligence and Life in the Universe.

http://www.ucmp.berkeley.edu/help/timeform.html - From the University of California at Berkeley, a web-based geological time machine to help in understanding the various sub-divisions of geological time on the Earth.

http://school.discovery.com/lessonplans/programs/earthspast/ - From Discovery Education's Lesson Plans Library, a very helpful guide to the teaching of Earth's dramatic history.

http://www.pbs.org/wgbh/evolution/change/deeptime/index.html - This interactive timeline called "Deep Time" covers 4.5 billion years of Earth's history, highlighting important events in the areas of geology, biodiversity, and extinction.

http://sci.waikato.ac.nz/evolution/EvolutionOfLife.shtml - From the University of Waikato in New Zealand, a really useful guide to the evolution of life on the Earth, organised into 20 sections referring to their biological and geological significance. Also includes many other links to aspects of Earth's history and evolution.

http://www.astrobio.net/news/Topic6.html - A collection of articles focussing on various aspects of the search for life on Mars.

http://www.astrobio.net/news/article1017.html - The Great Mars Terraforming debate from the Astrobiology Science Conference of March 30, 2004, where scientists and science fiction writers faced off in front of a packed audience to debate the promise and pitfalls of terraforming Mars.

http://www.astrobiology.com/europa/index.html#facts – A comprehensive set of weblinks relating to the possibility of life on Jupiter's icy moon Europa and the space missions proposed to explore this possibility.

http://planetquest.jpl.nasa.gov/index.cfm - From NASA's Jet Propulsion Laboratory, the PlanetQuest website has the latest on the search for planets around other stars and the many projects – both in-space and ground-based – involved in the search, including the quest for another Earth-like planet.

http://exoplanet.eu/ - The Extrasolar Planets Encyclopedia, maintained by Jean Schneider, is the definitive guide to everything relating to searches for extrasolar planets, with the latest news and an interactive catalogue incorporating the most recent discoveries.

http://setiathome.berkeley.edu/ - SETI@home is a scientific experiment that uses Internet-connected computers in the Search for Extraterrestrial Intelligence (SETI). You can participate by running a free program that downloads and analyzes radio telescope data.

http://www.seti.org/site/pp.asp?c=ktJ2J9MMIsE&b=178025 - The mission of the SETI Institute is to explore, understand and explain the origin, nature and prevalence of life in the Universe.