

There was all kinds of opposition to human spaceflight at the beginning of the space program (Mercury), through Gemini and Apollo, and even today with regards to the international space station. Engineers often felt as if engineering space systems to be able to support life was a burden.

Randy Lovelace was, essentially, the dean of post-war aerospace medicine. He laid out 15 technical areas that had to be investigated before sending humans into space.

Some people felt that putting humans in space would take attention and resources away from scientific endeavors.

One of the most intriguing “basic biology” questions about space is: Does extraterrestrial life exist? And following from that are all sorts of other interesting questions (under what conditions can life exist, what forms does it take, etc).

One of the most important “applied medicine” questions was (at the beginning): Can life exist in space? (in a craft) What will be the effects of the different types of radiation to which astronauts will be exposed, and how do you shield against this radiation? There was a lot of ignorance about exactly what the radiation picture was like, in space.

Other questions included: What would be the effect of prolonged weightlessness on the cardiovascular systems of the astronauts? What are the as-yet unrealized effects of gravity on this system? What will the effects be on the heart?

1958 HF and Life Science Issues:

1. Administration/organization: not clear how USAF and NASA would divide up various tasks/responsibilities.

2. Acceleration:

Problems with taking off (similar to problems experienced by fighter pilots at high G turns): blood pressure up in the head drops, leading to blackouts.

(For a long time, researchers did experiments on themselves to test their ideas. This practice went on for awhile, until in the 1970’s a list of “common rules” to protect human life was issued for researchers receiving federal funding.)

3. High-intensity space radiation, 4. Cosmic Radiation – they knew it was there, just not all the specifics

5. Nuclear propulsion

6. Ionization effects: re-entry effects

7. Human information processing: studying the relationship and differences between human actions during the simulations, and actions during the actual mission. This is still not very well understood.

8. Displays

9. Closed-cycle living, 10. Balloon simulators, 11. Space capsules

12. Crew selection and training: who would go? Scientists? Pilots?

13. Research centers for aerospace medicine

14. Launch sites: climatically favorable

Major Life Science Issues

Astronaut selection:

What should the medical requirements be for astronaut selection? You want someone healthy, not susceptible to the kinds of ailments that might interfere with the task at hand. Need a healthy cardiovascular system, capable of standing up to the launch stress and possible weightlessness stresses. Can't be susceptible to kidney stones, because they would be very hard to deal with in space; also, they are related to bone demineralization, which would possibly be more likely to happen in space than on Earth, due to weightlessness (based off of the fact that this happens in people confined to bed rest).

Decided to limit the selection to U.S. Military test pilots with some engineering background. This cut out many applicants, but there were still a lot (went from 1000 to 60 applicants). (Interesting to note: experienced submariners were rejected, though they have more experience in long-term closed spaces. Possibly this was due to their lack of experience with G-forces). Other general requirements were security clearance, and demonstrated ability to deal well with high-stress situations.

Life Support Systems:

Bare minimum requirements: must supply oxygen for the astronauts. Carrying along an appropriate atmosphere causes engineering problems, such as extra weight, requires more complex systems for mixing the air and delivering it to the capsule and removing CO₂, and you have to take the air inside the capsule into account when calculating the pressure inside and making sure it's not too high, which would cause the bends (N₂ bubbling out of blood). Can't use pure oxygen because it's flammable.

There's a large number of other factors that may need to be addressed [see slides]

What might be the aftereffects of having been in space? Would it affect fine motor control, vision, hearing?

“Separation” = psychological separation: feeling distant from formerly close personal relationships.

Exercise wasn't a large part of the astronaut training routine during Apollo, as it is now.

Space motion sickness = space “adaptation” sickness (NASA name): sense of nausea, headache, vomiting during spacewalking

Animals in Space First?

Wasn't exactly “successful” at first; many animals died due to problems with temperature regulation. Program was shut down after 3 flights by demand from animal rights groups; there were a few other private tests, and the Russian tests.

In-Flight Medical Monitoring:

Was hard because crews didn't like having to do it; it felt invasive to them (rectal thermometers, respiration was measured with an irritating band around your torso, etc.).

But also, importantly, the “doctor is not your friend,” in military flight, because he's the one who can pull you off the flight for a medical reason!

Physicians realized this, too, and had to wonder at times whether the astronauts were lying about how they felt. They also experienced pressure from both sides: the public often felt they weren't doing enough tests, while the astronauts felt they were doing too many.

These stresses built up mutual discontent across the whole program.

So, during Mercury, doctors on the ground monitored the crew simply by talking to them.

Astronaut Duties:

Astronauts were sometimes seen as backups for the automatic systems.

Astronauts as scientific observers: this was controversial; it took a fight to be able to utilize the test pilots' intelligence and other skills as scientific observers. Eventually, actual scientists were sent up as astronauts.

Crew training:

Space familiarization: how do you do this without actually being in space? They made do with familiarity with flight in general; astronauts were subjected to various tests that simulated different stresses and effects.

14 Day Gemini Key to Apollo Biomedicine:

Pneumatic cuffs: activated during re-entry to prevent shock and blackout that might occur as all the blood goes to astronauts' legs.

Bands: for muscle training while weightless

Life Science in Apollo

Planetary protection: goes both ways – protect extraterrestrial bodies from contamination with cells from Earth, and protect Earth from contamination by extraterrestrial cells or harmful minerals.

Original quarantining of Apollo astronauts was really ineffective; it's a good thing it turned out to be unnecessary.