Please answer the following questions in your discussion:

1. What macromolecule (you can only pick one) would you choose to search for as a definitive sign of current or past life on Mars?
2. What would be the maximum molecular weight of the Macromolecule that the Mass Spectrometer should be designed to measure?
3. If you had limits on molecular weight due to instrumental size, would your answer to question 1 change?
4. If you found the Macromolecule that you proposed to search for on Mars, how would you convince the scientific community and civilian community that you can definitively state that there is or was life on Mars? How this would change our perspective of life on earth and in the universe.

1. Nucleic acids with proteins are the most important macromolecules for the existence of life. If we have to pick only one macromolecule, it is DNA which is the repository for the genetic information. However, DNA is highly optimized for life on earth and alien life could rely on variations of the double-stranded helix DNA , and could contain more than four nucleotide bases: hachimoji DNA [1]. To increase its detection capabilities, the Mass Spectrometer should be designed to detect these different variations of DNA.
2. The average weight DNA is 340 Daltons, and we have:
   - Molecular weight of a double-stranded DNA molecule = number of base-pairs x 660 Da.
   - Molecular weight of a single-stranded RNA molecule = number of bases x 330 Da.

   For the human genome, the molecular weight is about 2.2×10^{12}Da, and for Escherichia coli, it is: 3.1×10^{9}. If instrument size is not a limitation, NASA Mass spectrometer could be designed to measure a maximum molecular weight of 2.2×10^{12}Da and below down to 3.1×10^{9} , covering a large range of species [2].

3. A limitation on molecular weight has a direct impact on the choice of the macromolecule to consider. RNA is essential to the translation of genetic information and regulation of gene expression, and has a smaller molecular weight (tRNA: 2.5×10^{4}, rRNA: 3.6×10^{4}), so we can instead calibrate the spectrometer for this molecule. Also, the standard proteins include 11 proteins from 6.5K to 205K Da, and if RNA molecular weight is still too large, a better choice will be instead to consider a protein.
4. There is a general consensus among the scientific community that, if DNA or RNA is detected, it will constitute a definitive sign of life. Whereas if a protein is detected more research will be required to reach the same conclusion. Note that alien life could be not-DNA-based and the non-detection of DNA is not conclusive of an absence of alien life. In any case, the discovery of DNA or its variants, will intensify efforts for space exploration, space experimentation, and the goal to perform more advanced biological research on other planets.

[1] S. Hoshika *et al.*, "Hachimoji DNA and RNA: A genetic system with eight building blocks," *Science*, Feb. 2019, doi: 10.1126/science.aat0971.
[2] "molecular-facts-and-figures.pdf."