I addressed two projects at DMI: (1) Miniaturized flow cytometry for outer space and terrestrial laboratory settings and (2) a submission for the Qualcomm Tricorder XPRIZE (QTXP).

The developed miniaturized flow cytometer has complete blood count (CBC) and blood chemistry analysis capabilities when coupled with a proprietary particle immunoassay platform. Over the past year the technology has reached early commercialization in a 1.5 kg USB-powered desktop unit (called the 'rHEALTH One'), through a combined team effort. In addition to designing a fluidics module for the system, I focused on improving design for manufacturability of the central device component -- the optical 'block' (a surface that holds lasers and other optical components). I also sought to publish previous efforts related to reduced-gravity (R-G) parabolic flight testing of the technology. Despite the long history of parabolic flight testing, there are few published detailed examples of how to approach R-G in vitro diagnostic testing, particularly when multiple component demonstrations are involved.

The QTXP is for a consumer device capable of diagnosis of 15 diverse conditions (e.g., urinary tract infection, anemia, COPD, acute otitis media, hemorrhagic stroke). We needed to conceive adaptation of our current technology and integration with other sensors to cover all conditions. I contributed substantial effort in producing and obtaining documentation for qualifying round submission, including successful IRB application from NASA for final round testing.
Describe how the project supported your progress towards the MD degree and/or your future career path in medicine:

Work relating to medical diagnostics is generally useful to improve understanding of how lab tests work, what the limitations are, and how they can be improved.

The multidisciplinary requirements for development of flow cytometry and its broad medical applications make such a project favorable to scholarly outcomes, either related directly to medicine or to technology with medical applications. A driving force for development of medical diagnostics with space applications is that, in many ways, outer space is the 'gold standard' for the 'resource-limited' environment, with additional engineering requirements to produce highly robust technology resistant to vibration, gravity changes, and other factors. Basically, if you can make it work in space, chances are you can make it work anywhere. Because of my desire to pursue medical diagnostics in the future, publishing the above described paper was important. Additionally, a second first-author paper relating to our novel microfluidic blood-mixing technology (necessary for sample preparation for flow cytometry) has been completed and was submitted for publication. It currently requires revision and resubmission.

The QTXP project was highly stimulating for me as an aspiring physician because it forced me to examine how I perform diagnoses from a mechanistic standpoint. Because the project requires development of a consumer device capable of automated (or semi-automated) diagnosis (of 15 conditions) in the hands of a consumer, the underlying methods for arriving at a diagnosis must be predetermined. As I sorted through each condition in the competition, the nuances of diagnosis, even for seemingly obvious conditions such as AOM and UTI, and the limitations of any given lab test became evident and had to be addressed. It was also useful to go through more administrative type tasks, such as obtaining institutional review board (IRB) approval for testing of our device.

List competencies/academic requirements achieved. Check all that apply and provide method (see attached sheet for competency definitions):

<table>
<thead>
<tr>
<th>Competencies/academic requirements</th>
<th>Method(s)</th>
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<tbody>
<tr>
<td>Medical Knowledge</td>
<td>Extensive literature review, read hundreds of papers this year across many fields of medicine.</td>
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<tr>
<td>Clinical Skills and Patient Care</td>
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<tr>
<td>Scientific and Clinical Inquiry</td>
<td>Development of flow cytometry and related technology. Plus multifunctional diagnostic solution for QTXP.</td>
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<tr>
<td>Professionalism</td>
<td>Staying in communication with others, meeting deadlines, keeping clear records of work</td>
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<tr>
<td>Interpersonal and Communication Skills</td>
<td>Multiple meetings per week.</td>
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<tr>
<td>Systems of Health Care</td>
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<tr>
<td>Continuous Improvement of Care Through Reflective Practice</td>
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Did this experience produce a scholarly outcome?  ✔ Yes  □ No

If yes, check all that apply and provide details:

Outcome type

☐ Research paper

✔ Journal article
  1st author paper 'in-press' at Journal of Visualized Experiments; a second paper requires revision/resubmission

☐ Poster presentation

☐ Presentation at a meeting

☐ Reflective writing

☐ Audio or video project

☐ Art project

☐ Other:

Information for future students who may undertake a similar project or one related:

It's key not to spread oneself too thin. I probably took on too many aspects of our project simultaneously -- publications, working on the core tech, adapting the tech for the XPRIZE. Having clear, demonstrable scholarly outcomes should be a priority. Once those are achieved or set in motion, it's safer to branch out.