Dear Reader,

The following is a rough sketch for the development of a nonprofit organization to support growth of the synthetic biology ecosystem in the Midwest. It is an outgrowth of the proposal for a regional iGEM competition, known as the **Great Lakes League**. Support of this league will one of the primary missions of this organization. For information on the league, please jump to page 8. The rest of this proposal will attempt to fulfill information for incorporation and a business model canvas for a typical nonprofit. We hope that this document can showcase our diligence in formulating these plans and inspire your support or participation in this endeavor.

Best Wishes,

Devin Camenares and Sakti Subramanian

Our purpose

To foster the growth of a synthetic biology community in the Great Lakes region; to encourage development of synthetic biology innovations and enterprises with a particular focus on solving environmental and ecological challenges unique to the Great Lakes, and to help invigorate the bioeconomy of the region, primarily through educational programs.

Organization and Action Plans

Key Partners

Educational institutions, including high schools (via regional organizations and districts, such as GIRESD), community colleges, and 4-year institutions. Ancillary nonprofit organizations that are focused on education, such as the MiSTEM network and the Michigan Colleges alliance.

Related regional organizations, include MichBio (a biotechnology industry trade organization that also promotes education and training for this career pathway) and SynBio Canada. We will coordinate our outreach activities, cross promote, and collaborate on fundraising activities.

Other synthetic biology organizations and nonprofits in other regions, such as the iGEM foundation, BioMADE, Genspace, SynBioBeta, Cultivarium (and their partner/patron, the Schimdt Futures Network), Genetech's FutureLab+, and the BioBuilders club..

Key Activities

Organizing, promoting, and supporting the **Great Lakes League**, a regional synthetic biology competition in the style of iGEM. We may hold other types of contests that will offer additional pathways for students to participate (see the **Great Lakes Synthetic Biology Seasonal Challenge).**

Helping to grow the synthetic biology ecosystem and economy in the Great Lakes region; Spreading awareness of synthetic biology and empowering a new generation of genetic engineers.

This will involve marketing and advertising the program and the organization, in order to recruit students and institutions to participate and to raise funds to sustain the program. Organizing the competition will require making resources and rubrics available, educating participants or connecting them with proper mentors, and organizing the meetup.

We will also cross-promote other organizations that are involved in Synthetic Biology, such as the BioBuilders club. We can act as regional liaisons for these larger, national or international programs, to help foster development of a synthetic biology community in the Great Lakes region.

To support the competition, we will need to raise funds to provide resources, host a website, and support a small staff dedicated to this work. We will also raise money to help support participants via grants.

We will act as a coordinator or consultant for schools that wish to participate in the programs we offer. We will actively engage with them to craft pathways for them to enter

into our own programs or others, and to better integrate the experience into their activities.

Funds that are raised can be used to support programs, as well as provide grants to schools that want to secure SynBio educational materials, such as BioBuilder kits or BioBits from miniPCR Bio.

Key Resources

To accomplish this, we will need financial support to cover marketing expenses, educational materials, and have a dedicated, full time staff.

Resources we already have include a board of directors with considerable experience in organizing iGEM-style teams and promoting synthetic biology. We also have relationships with partners in higher education.

For internal organization, we will use freely available or inexpensive resources such as JOGL, Google Sheets, Asana, Discord and Slack.

Social Value Propositions

The program and service we will primarily deliver is the Great Lakes League, a regional synthetic biology contest. The problem we are solving in doing this is a lack of participation for students and institutions in the area in the field of synthetic biology. To co-creators, we bring value in terms of better student engagement, better training for synthetic biology jobs and companies, and a more aware and supportive regional community for synthetic biology startups. We hope to create an environment in the Great Lakes region that is conducive to the growth of a synthetic biology economy and to provide opportunities for people (students) in the area to experience this field in preparation for participation in such an economy.

Other organizations exist that fulfill this need in part. MichBio has multiple functions for the biotechnology industry in Michigan, including forging connections between companies and educational institutions and informing special programs, curriculum, and advising. Their organization is focused on the medical and biotech sector as a whole and includes a wide range of companies and organizations. BioBuilder club and Genentech's FutureLab+ provide instructional material to high school students to initiate them into synthetic biology and biotechnology. However, these are often designed as teaching modules that can be delivered independent of others using the same approach. Finally, organizations like iGEM provide a means for students to engage with synthetic biology in a way that presages the development of a synthetic bioeconomy. However, significant barriers exist to participation in iGEM. The goal of our organization will be to draw from each of these

efforts and act as a sort of glue – a way to build a community of engaged students that are connected with local institutions and companies.

Collaborating institutions of higher learning will benefit from increased student engagement, which should lead to a higher quality education and increased recruitment and retention of these students.

Relations

We seek to build a community of institutions in the area that are interested in synthetic biology.

For our collaboration and co-creating educational institutions, we aim to provide instructional material and mentorship in the competition. In this way, we hope to replicate what iGEM has done with the mentorship program and the ambassador program, but on a more intimate, regional scale. We will meet with principals, high school teachers, and faculty members at community colleges and universities to promote our work and help connect them with appropriate resources and synthetic biology programming for their students.

For institutions of higher learning, we hope to establish relationships that help build a pipeline from high schools to their institution. For example, we can help coordinate scholarship programs in synthetic biology at participating institutions.

For other institutions that provide educational resources (i.e. Genentech or BioBuilder) we hope to cross promote their programs and provide additional inroads for them in the Great Lakes region.

For organizations that coordinate economic development, we hope to provide a better prepared and engaged pool of student talent, so that they may further expand their business into the field of synthetic biology. We will also try to connect participants in our programs with resources for startup development, helping to bridge the gap between the educational organizations and the business groups.

Channels

We will reach co-creators and collaborates via direct contact (email), organization meetings (MichBio Talent Exchange Event, regional iGEM and SynBio meetups). The authors already have a network of contacts that extend to many collaborating organizations.

For other educational institutions (high schools), we will follow both a bottom up and top down approach to contact. The bottom up approach will rely on students currently engaged in the synthetic biology field, such as iGEM students at Alma college, to reach out to their

science teachers from high school and initiate contact. The top down approach will start with contacting principals and superintendents, as well as state-wide coordinators such as the Michigan Colleges Alliance, the Henry Ford Foundation, and the MiSTEM Network. We will offer to come to schools to present an overview of the field and the career opportunities.

We will establish a website and social media presence to showcase our work and reach out to others.

We will also reach out to potential collaborators by publishing relevant articles and commentary on other platforms. For example, we will write an essay for Grow magazine (published by Ginkgo – an open call for essays for the upcoming issue on scalability has recently been made) and for Issues in Science and Technology, among other venues (such as peer-reviewed journals on STEM education). We will also seek to gain recognition on iGEM's own media outlets (blog, podcast) and, most importantly, local media outlets.

Co-Creators

We will be creating value for educational institutions and companies and groups interested in a student population that is better engaged with synthetic biology. We anticipate the following types of co-creators and stakeholders:

Investors, Philanthropists

These include groups such as the Sloan Foundation and the Schmidt Futures group, and grant challenges on experiment.com. They will be grant awarding organizations or individuals and groups interested in providing donations. They will gain recognition in our promotional material for their support.

Recipients

Students will be the direct beneficiaries of our programming, which is primarily designed to give them an enriching educational experience. Students will gain skills and knowledge regarding synthetic biology, which can be useful for their academic or career journey to come. Even more importantly, the structure of our programs (the regional competition) will challenge students in areas of teamwork, communication, and organization. Recent feedback from an industry event (MichBio's Talent Exchange) clearly emphasized the importance of these 'soft skills' for employers in the industry.

Volunteers and Collaborators

We anticipate a volunteer base for current and former iGEM participants in the area. Students that are currently engaged in iGEM can volunteer time to help run our programming and outreach – this will help satisfy the education and outreach components of the competition for those students, as well as the collaboration criteria. Former participants have demonstrated a passion for synthetic biology, and may appreciate this way of supporting others as they begin a similar journey into the field. Other faculty members and teachers likewise committed to better outcomes for their students would be expected to participate.

For these volunteers, we will recognize their efforts in ways that attempt to support their own careers – for example, trying to establish a structure by which high school teacher can count synthetic biology training and participation as professional development.

Customers and Members

Members may include the educational institutions or students themselves. Participation in the competition will be offset by fundraising, but will not be free. We may, however, allow participation from any number of students or teams from schools with a special membership relation. We may also help to provide discounted supplies relevant to the competition to members.

We will also create a synthetic biology newsletter and podcast, with at least some content that is exclusive to members.

Cost Structure

The most significant cost will be the compensation provided to full time staff for the organization. Although we will pilot as a volunteer organization, we eventually hope to expand with the help of a paid staff. We will have a full-time staff that will initially consist of:

- An executive director will coordinate with the board in promoting the organization and spearheading fundraising activities. They will meet with individuals and organizations to solicit gifts, review grant proposals, identify potential funding sources, and ensure a smooth fundraising operation. They will also work to explain the importance and success of the organization's work to the outside world.
- An executive assistant will help coordinate the director's activities, and help to administer the program, and coordinate volunteer activities. In particular, they will work to find ways to expand the reach of the program, manage social media, and gather the information on impact.

All other responsibilities will be shared by volunteers in the program initially. As the program grows, we would seek to expand our operations and roles by splitting these roles

(for example, the executive director position can delegate some responsibilities to a development director more specifically charged with fundraising, while the executive assistant role can be split into a volunteer coordinator, development staffer, etc).

Other costs can include promotional materials (websites, printouts, etc) and materials for volunteer morale.

The cost for the actual administration of the program and the resources needed for it should be relatively minor, including travel and the organization and catering of meetups and events.

The organization will also feature a board of trustees, and liability insurance for the board will be explored. Board members will be expected to volunteer time fundraising and helping to promote the program, as well as act as an advisory committee on the structure of the competition.

Outcome Streams

With money raised, we will return this in the form of educational resources to students participating in the program, scholarships for them to continue an education in synthetic biology, and grants for development of other synthetic biology programs (i.e. covering expenses related to BioBuilder or iGEM).

Our primary outcomes will be the activities of the Great Lakes League and similar programs (see following pages). We will also disseminate the successful aspects of the project via peer reviewed publications and other media outlets.

The Great Lakes League Proposal

The following is a proposed framework for an officially sanctioned iGEM league for the region surrounding the Great Lakes (The Great Lakes League, or “GLL”). It includes a rationale for why this league should exist, how it can grow to encompass the surrounding region and reach the target number of people. It also offers a calendar for implementation, medal criteria, and supports the argument by demonstrating that the capability for starting such a league exists. Specifically, I will address the five criteria necessary for a league, as defined by iGEM HQ (https://leagues.igem.org/) 1: The proposal is based on the synthetic biology needs of its region or country. 2: They have a measurable “local communities solving local problems” component and provide an iGEM experience. 3: They aim to define, develop, and participate in the regional synthetic biology ecosystem and bioeconomy. 4: They have a clear strategy to impact over 5,000 people within its first 3 years of inception. 5: They have the right team and strategy to carry out the League’s vision successfully and become sustainable within 3 to 5 years. Overall, this league is intended to act as a bridge for students to gain skills and resources necessary for participating in the international competition.

Why the Great Lakes Region?

The Great Lakes region is being defined here to encompass 5 US states; Michigan, Illinois, Ohio, Wisconsin, Indiana, and the Canadian Provide of Ontario. Although parts of Pennsylvania and New York also contact the lakes, the regions identified, especially Michigan, Illinois, and Wisconsin, have state-wide economies, ecosystems, and population centers significantly effected by the lakes.

Michigan

Michigan is a US state centered among the Great Lakes Region, the largest body of fresh water on earth, and features the second longest coastline of any state behind Alaska. It has traditionally been a center for manufacturing, and also features strong industries in agriculture and education. This combination of economic activity, environment, and geography lead to some interesting consequences – for example, Michigan experiences both current and legacy pollution problems that threaten a unique ecosystem.

While Michigan is arguably best known to others in the US for the development of the auto industry (which has since greatly diminished), it recently gained national attention for the contaminated water crisis in Flint, MI[1]. Unfortunately, the pollution problems are more extensive and deeper than one city. Algae blooms in Lake Erie affect neighboring states and Canada, and PFAS contaminates other lakes and waterways. Failing septic systems and agricultural runoff also make some rivers unsafe for drinking or even human contact. For example, this is true for the Pine River as it runs through Alma, where extremely high bacteria counts (some of which are antibiotic resistant) can make swimming dangerous. Downstream, in the neighboring town of St. Louis, effects are still being felt for PBB and DDT pollution events in the past[1]. These problems impact wildlife and the agricultural sector. They also exacerbate human health issues in a state with one of the highest incidents of heart disease and cancer in the country[2,3,4].

The development of synthetic biology in this state can both revitalize the economy, and cleanup and protect the environment. To accomplish these goals, the next generation of scientists and the communities in the Great Lake regions must be aware of this emerging new field and actively engage in its practice. Learning how to apply synthetic biology to solve real-world problems, even just in the context of an iGEM project design, will empower them to seek and create the solutions to the myriad of challenges facing the state and the region.

In recent years, there have only been three iGEM teams from Michigan, representing the University of Michigan, Michigan State University, and Alma College. However, there are over 150 institutions of higher education in the state, representing over 415,000 undergraduate students[5,6,7]. Due to impending demographic challenges to recruitment and admissions, many of these colleges and universities will be hungry for new, innovative, and engaging programs. This represents a large pool of potential participants, given the right outreach. The current iGEM teams can help spearhead these efforts, as they are centrally located in the state (Fig 1).

Taken together, we see a picture of Michigan and the Great Lakes region emerge: an area with significant pollution challenges to a unique and valuable ecosystem and environment. A region for which agriculture is an important industry, impacting both its population and the entire nation. A population that strives for a more innovative economy and more opportunities – one that is grounded in manufacturing, but also chemistry (Dow chemical) and medicine. A population without a developed synthetic biology ecosystem, but with a

great potential for one. An iGEM league for this region can be the catalyst for a transformation of this area and the people, bringing opportunities and cleaner water.

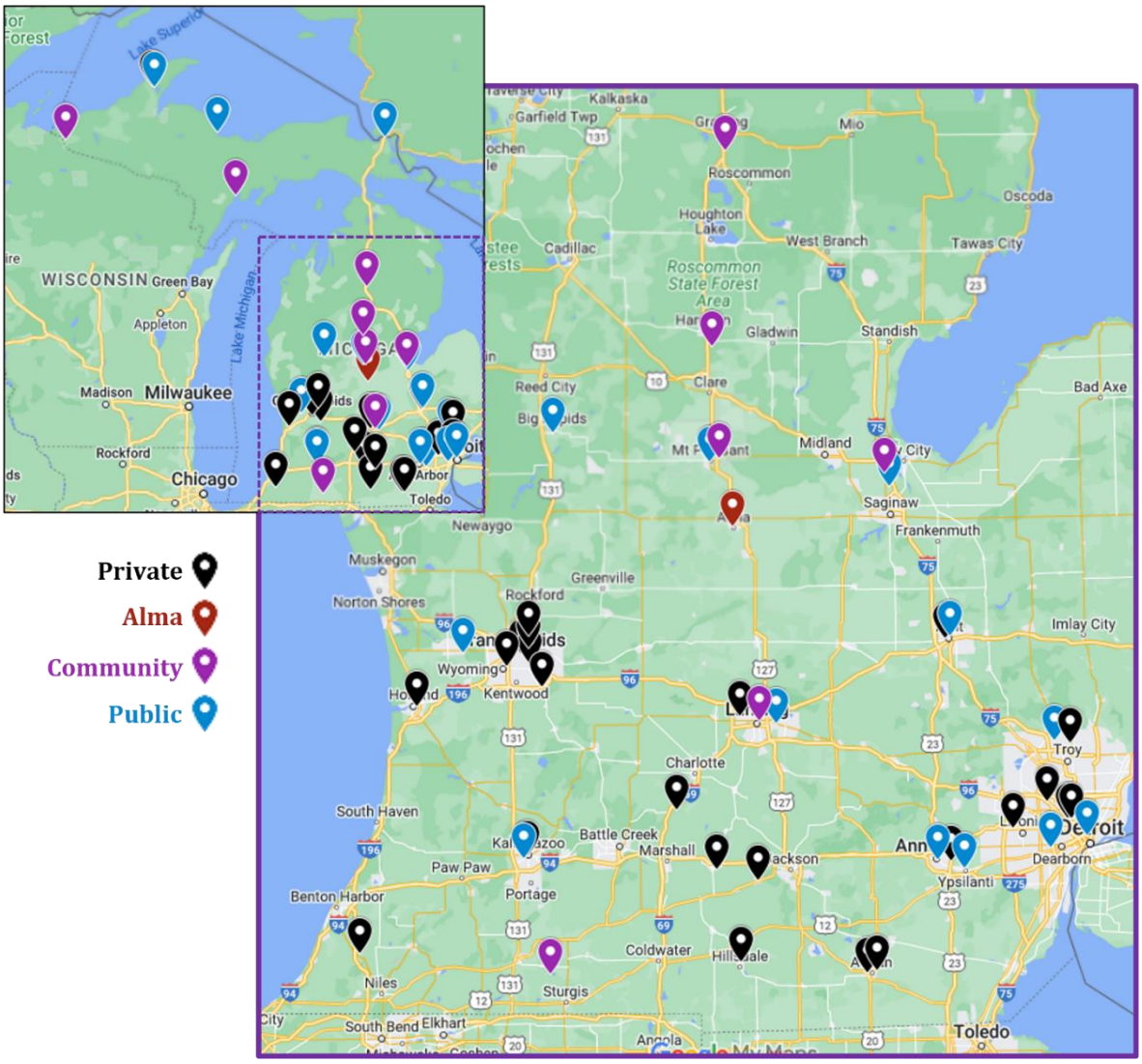

Figure 1: A map of selected institutions of higher learning across the state of Michigan. The focal point for this proposal, Alma College, is shown in Red, while other private institutions are Black. Public universities are shown in Blue, and Community Colleges (a key target of this proposal) are shown in Purple.

Illinois

The biggest city in the Midwest, Chicago, sits directly on the Great Lakes. While other large cities on the western and eastern coastlines, such as Boston and San Francisco, have developed a synthetic biology ecosystem, Chicago has not. There have been embers which could have fueled such development, such as several iGEM teams participating in the region's institutions of higher education, and a community lab for the DIY Bio movement (BioBlaze). However, these forays into synthetic biology have not been sustained in recent

years. A regional iGEM league could help resurrect some of these programs and drive this as a center for industry.

Plan for Growth

While the foundation for this proposal is rooted in the mid-Michigan and Chicago areas, there is potential for growth throughout the Great Lakes region. For a target of 5,000 participants (or people otherwise impacted) in 3 years, we would need to capture approximately 1% of the undergraduate population of the state. For the greater region, which would include neighboring states of Ohio, Indiana, Illinois, and Wisconsin (as well as Ontario in Canada), the potential pool of undergraduates is greater. The Cities of Chicago (40k), Toledo (13k), Milwaukee (70k) and Madison (35k) alone would vastly increase the size of the pool of undergraduates that could be potentially impacted[8,9,10,11].

Several of the larger institutions in this greater area have fielded iGEM teams in the past, and may have the resources to compete on an international level. However, there are many other colleges, particularly community colleges and private institutions, which would find participation in a regional league more appropriate. We can create a league in which there are less barriers to entry, a great first step and initial foray into the field for some of these institutions. In addition to providing a way for these students to engage in synthetic biology by itself, the regional league may act as a bridge to the international competition. By providing support, training, and experience, the league could allow a community college or even high school the chance to build a track record of success and justify allocation of resources for the international competition in the future.

This is probably most relevant at high schools in the area. Michigan currently has a high school population of approximately 450,000 students across over 1800 high schools[12]. Once again, capturing only 1% of this population would reach our goal. Preliminary outreach from the Alma College iGEM team has shown that synthetic biology is well received by students, who are excited by the prospects of applying their knowledge to solve real-world problems. Together with nearby community colleges (over 20k students), this would form the main target population for the regional league. Moreover, by targeting high school students, especially juniors and seniors, we would hope to have them carry their interest in synthetic biology to whatever college they attend, accelerating participation in the league by institutions across the region.

The development of an iGEM team that has taken place at Alma College has been an interesting test case for how similar groups of students might come together at other small colleges in the region. At Alma, we started with a small group of about a half dozen interested students. With the backing of the institution, and celebration of their early success, these students were able to effectively recruit additional members and spread awareness of the program. Many of their classmates, and other prospective students, were immediately excited by the field and the chance for them to design and develop a student-

directed project with their peers. This was also accelerated by integrating iGEM with existing classes and activities on campus. We now have a team of about two dozen students and a larger club of supportive students of about the same size, totaling approximately 50 students that participate in a given cycle. Moreover, the impact of the team is not limited to the team members or supporters. Nearly all students on campus are now aware of the iGEM team and of synthetic biology. The same is true for the faculty and other community members in Alma. The outreach the team has conducted has also impacted residents and businesses of nearby towns. If this model is even partially replicated at other institutions, the reach of the regional league could be far greater than the student population numbers might suggest. In fact, this will be incorporated into the league by design – teams will have to engage in outreach and document the impact they are having, and the medal criteria will include requirements for the size of this impact.

As detailed further in the proposed implementation below, we envision a multi-year phased approach to this regional league. In the first year, we would lay the foundation for the league by promoting it, holding workshops, and preparing high school and community college students to participate. This will replicate the model used by the iGEM Indian league. In Michigan, this outreach will be spearheaded by the Alma iGEM team, but we will also attempt collaborations with the team at Michigan State University to better cover schools in the more populated regions of Lansing and Detroit. This GLL workshop will serve to both introduce synthetic biology to these students, and to explain the contours of the competition for the following year. Our goal will be to reach at least 10 high schools, 2 community colleges (Delta and Mid Michigan – collectively 7k students), and 1 public university (Central Michigan University, 17k students) with this approach. Assuming we only reach high schools similar to that in Alma (approximately 600 students), and only 1% of the student population participates in the workshop, we would still reach 300 students in the first year. With support from state agencies which have been receptive to this idea, it is likely that we can reach more schools and colleges in the first year.

In the following years, we would expect considerably more growth. The first full season of the competition in 2024 would hopefully feature teams at colleges with students that experienced the workshop as a senior in high school the previous year. We will continue the outreach efforts and the workshop each year as well, targeting new students and new schools across the state. Our goal will be to at least triple the size of the program over the course of the next two years. For example, 300 students in the workshops in 2023, 500 both competing and in workshops in 2024, and 900 in 2025 (for a cumulative total of 1700 participants in this time).

After two full seasons focused primarily on Michigan and the greater Chicago area, Great Lakes League will expand the same efforts to include colleges and schools in Wisconsin, Indiana, Ohio, the rest of Illinois and even Canada. We expect to hit a target of 1,700 new participants when we reach this level in 2026. We think this is attainable, especially with additional support from the iGEM foundation, such as coordinating our efforts with the North American Ambassador.

While we would like to hit our participation goal a year earlier, and nominally conform to the criteria for a regional league (impacting 5,000 people within the first 3 years of inception) the first year in this proposal is dedicated to laying the foundation, and the league would not start in earnest until 2024. Moreover, the impacted population need not be limited to participants, but will be measured to include stakeholders and the broader public that is made more aware about synthetic biology. Given the amplification in impact that we have seen in Alma, we would expect the number of impacted people to be at least triple that of the actual participants. Therefore, with our goals we are likely to impact 900 people in 2023, and cumulatively over 5,000 by 2025.

Our projection of 1% of the population for a given institution may be a modest goal in some settings. For example, at Alma College, 50 participants in iGEM translates to almost 4% of the student body. Our recent outreach to a local high school (Shepherd, MI) got an audience of 20 students out of a total student body of approximately 500. At least half of these students expressed interest in the regional competition idea, or roughly 2% of the student body. A more concerted effort to recruit participants would likely be even more successful.

A similar situation likely exists at other institutions and colleges. For example, out of Calvin College's over 3,000 undergraduates, about 9% are engineering majors and 4% are biochemistry majors. Similar proportions exist at Hope College (~2900 students, 6% engineering, 4% biology), and Wayne State (~17k students, 4% biology). Central Michigan University has 13k students, almost 3% of which major in Cellular and Molecular Biology. Northern Michigan likewise has 6% biology majors in a population of 6.5K students, and 4% of Michigan Technological Universities 5.5K students major in bioengineering[14]. Assuming only half of these majors, and ignoring likely participation from other majors, would likely underestimate participation but still meet the goal of 1% of the student body. As a point of reference, approximately 10% of Alma graduates are awarded a degree in Biology or Biochemistry.

One of the advantages to a regional iGEM league is having a local support group to encourage and facilitate participation. Students at Alma College will continue to spearhead these efforts, and can easily travel to many parts of the state thanks to our central location. By meeting with their soon-to-be peers, high school and community college students are more likely to be receptive to participation in a league.

Proposed Implementation

Costs

We would propose a modest team fee of $60 to help cover costs that might be related to administering the program – holding the workshops, providing mentorship or advice to teams, etc. This is again designed to create a low barrier of entry for teams, and even make it feasible for teams consisting of one student and an advisor to compete (see team composition below). This is based upon feedback received from Dr. Eric Petersen at Central

Michigan University (who has expressed interest in participating in a regional league). For in-person attendance at the regional meetup, an additional $15 per person fee will help offset costs associated with running the meetup and providing refreshments (these costs will also be offset by the admissions department at Alma College).

Calendar 2023

This year we will build the program by further spreading awareness of synthetic biology and iGEM across the state and bringing resources and education to students that are interested in participating. The Alma iGEM team, as part of their educational outreach, will help connect college and high school students with league educational resources and a pilot version of the educational workshop.

Calendar 2024 – a Typical Season

The competition will take place from March 1st to December 12th, 2024. The calendar is designed to allow for additional recruitment and preparation in the beginning of the year for the program, to give time for students that are either in high school or college to start while they are together during the Spring, give them time to continue the work over the Summer, and ample time to finish their work during the Fall and Winter.

As a contrast to the standard iGEM competition, where there is one in-person cumulative event at the end, in the regional version there will be an in-person event in the middle of the competition. There are several reasons for this change; the primary one is to allow teams to take insights they learn from the in-person meetup, which is as much a workshop as it is a chance for presentation, and then further refine their project in the remaining months. Another reason is to allow this regional competition to interface with the international event better – it incentivizes teams competing in iGEM to attend the event and present their project, to both practice its delivery, get feedback, and demonstrate outreach and collaboration.

Here are some key dates

- January 1st to March 1st – team registration. A host of introductory materials and videos will be provided to help guide the initial steps of the project, and prepare them for the workshop.
- Second week in March – attend introductory workshop (online).
- Fourth week of April – consultation with mentor about project.
- Second week of July – mentor check in and consultation.
- Third weekend in September – League meetup event at either Alma College or in Chicago. All teams need to send at least one representative for a full day symposium. They will give a short talk that describes their project and the progress they have

made so far, and workshop with others on how to improve. iGEM teams in the area (Alma College, MSU, etc) will present their work as well.
- December 12th – All project materials are due – files for all of the criteria must be submitted by this date.
- December 13th to December 23rd – Review of materials by the Judges. Results are announced at the end of the day on the 23rd.

Team composition

Each team must consist of one or more students at a high school, community college, or other educational institution from either Michigan, Illinois, Indiana, Ohio, Wisconsin, or Ontario (Canada), together with at least one advisor (a teacher or faculty member that represents the institution). Note that a faculty member can act as an advisor for multiple teams or individual students, if necessary.

For example, there might be a team from Shepherd High School in Michigan consisting of Rick Coon and Alan Gamble as advisors with 10 students. It would cost the team $60 to enter the competition, and at least an additional $30 for 1 student and 1 advisor to attend the regional meetup (or an additional $180 for all of them to attend – for a total cost of $240 for the year, which should be manageable for such an institution).

We could also imagine several individuals participating from Central Michigan University separately. There might be 5 students that all compete individually ($75 each to enter and attend the Jamboree) that all list Dr. Eric Petersen as their advisor. These individuals could all be working on separate projects – they would still be subjected to the same medal criteria as teams with multiple students, although would compete amongst themselves for the best individual project award.

Why structure this competition in a way that would also allow for individuals, rather than just teams, to compete? There are several reasons for this decision. While we would encourage students to work together in the context of a larger team, as is the norm for iGEM, in some settings it may be difficult for students to organize this way, or more convenient for them to pursue solo projects. For example, students that are already engaged in independent research or developing projects for a class might find it easier to continue that work and convert it into a project for this competition. Of course, they will face the daunting task of trying to complete all the medal criteria themselves, but in turn this may be an enriching experience that will clearly illuminate to them what is required of different parts of an iGEM team. This type of experience might serve as excellent preparation should they be part of a team effort in the future – perhaps on a team in the international competition.

Medal Criteria

The medal criteria for the Great Lakes league will take inspiration from iGEM itself, and the other two leagues that already exist (the Latin American Design League and the Indian League). The proposed criteria were developed with the intention of making this type of science accessible to institutions and students that do not have the resources to develop and complete an iGEM caliber project, but still have the passion and drive to design a synthetic biology solution to a real-world problem. For that reason, we tried to limit the number of criteria that relied exclusively on wet-lab work – while still preserving this as an option for teams to demonstrate excellence. However, teams successful in these criteria should be well suited to compete at the international level and earn at least a bronze. We also seek to be different from the existing examples as a way of experimenting and exploring this space for the benefit of future leagues elsewhere.

Bronze Medal: Complete

- Attend the (online) educational workshops offered by GLSB and complete the exercises.
- Attend the in-person league meetup in September and present the project in progress, and submit all final materials by the ending deadline (Complete deliverables). At least one team member needs to attend the meetup.
- Project Description – You have defined **a local problem** and highlighted its importance. You have also identified what current solutions exist or have been proposed.
- Attribution & Impact – You clearly delineate who has made which contribution to the project. Moreover, you clearly record and **quantify the impact** your project had. How many people participated, or had been involved in some way, or otherwise impacted by the work you did? This can reflect aspects of other criteria, such as human practices, outreach, and entrepreneurship, or recruitment of others into the league.

Silver Medal: Complete 3 out of the Following 4 Criteria

- Proposed Design – You clearly shown how you will use **Synthetic Biology** to solve this problem, clearly indicating the DNA parts you would use, why they have been selected, how they will interact, and given an outline of how they are to be assembled and tested (if not actually providing data).
- Outreach, Communication, or Education – You have engaged in well-documented outreach, to help raise awareness of your problem or to educate the broader community about synthetic biology. This can take many forms, but must all involve some interaction with stakeholders or community members from outside your group. Your outreach must impact group(s) that total to at least the size of your team.

- Safety – You have proposed ways in which your project could be implemented safely and ethically. This could include the design or incorporation of an appropriate safety or kill-switch, or some other recognition of the risks involved in the project.
- Human Practices – You have considered the broader social, ethical, economic, or political ramifications for your project, and put your project in proper context amongst these issues. This can be based solely on research and reflection – incorporation of outreach and feedback into this process is encouraged and qualifies for the Integrated Human Practices criteria.

Gold Medal: Complete All Silver Medal and 2 out of the Following Criteria

- Entrepreneurship – You have generated a business plan and have identified a pathway to moving your project from the theoretical to the marketable. For example, you have created a detailed Business Model Canvas.
- Mathematical Modeling – You have refined your proposed design and created a mathematical model of how some aspect of it should behave. You have drawn a conclusion from your model that can help provide insights into your project design.
- Integrated Human Practices - You have clearly shown how your outreach has informed your outlook on the issue, and the proposed design. You have integrated feedback you received into your project in a significant way. This is where the "outreach" meets "inreach"! To qualify for this criteria, your outreach must also impact group(s) that total to at least double the size of your team.
- Contribution to the iGEM Community – This could be accomplished through better characterization of an existing part, creation and testing of a new part, or even just more literature research that can be added to an existing part's page. This will be added to the registry by an official team with attribution to the GLSB participant that carried out the work.

Judges

Volunteer Judges will be recruited from the ranks of iGEM teams and faculty in the area, and from other interested state agencies and companies (see support structure below). This provides these teams with additional outreach opportunities, and helps foster connections between synthetic biologists in the region. If necessary, outside volunteer judges will be sought after.

Awards

Students that are on a team that receives a gold medal will receive scholarship funds, provided either by a supporting charitable organization or by a partner institution (such as

consideration for transfer or enrollment at Alma college). This provides some extra incentive for participation. The amount of this award is yet to be determined.

There will also be prizes for best overall Individual (Solo project), High School team, Community College team, and University (4-year) team.

In addition, the biochemistry department at Alma College has surplus laboratory equipment. We will donate this to winning or gold medal teams, to help them build resources for future iterations of the competition and prepare for the international event.

Support Structure

There are sufficient resources, institutions, and expertise in Michigan to support this endeavor. There are three institutions that currently have iGEM teams in Michigan (Alma College, Michigan State University, and University of Michigan), and several groups and people committed to the idea.

The primary organization to sponsor and coordinate the league will be the Great Lakes Syn Bio group. This is a 501c3 nonprofit organization that was formed for the purpose of supporting this league, and generally growing the regional synthetic biology ecosystem. They will act as a channel for charitable donations to run the league, and will have both advisors / board members (such as the authors of the proposal) and full-time staff dedicated to carrying out this mission.

One of the authors of this proposal, Dr. Devin Camenares, has been involved in iGEM for almost a decade. He has served as a primary team mentor at both the community college (Kingsborough 2016 & 2017) and 4-year college level (Alma, 2019-2023). In addition, he has been a Jamboree volunteer (2013 & 2014), served twice as an iGEM judge (2017 and 2018), served as member of the After iGEM Education Steering Committee in 2021 (wherein I helped to develop the EduHall initiative), and was a synthase workshop contributor and judge in the iGEM Indian League in 2021 and 2022. Finally, he will be helping to lead the SynBio 101 initiative in 2023. He has been exploring the idea of a regional league in Michigan for several years, and has gotten feedback from a variety of potential supporters.

Dr. Camenares, together with the Alma iGEM teams, have conducted outreach to local high schools over the past few years. In addition to traveling to high schools in Alma, Shepherd, and other locations and giving demonstrations or leading laboratory activities, they have run a 1 week synthetic biology camp as part of Alma's CORE research experience. Students in this camp learn about the field, the way in which iGEM teams solve problems, and even get to carry out PCR and DNA assembly. This work has also cumulated in the development of a novel variation on DNA assembly, specifically for BioBricks in the iGEM collection. This assembly approach, coined "GEM-Gate", allows for unlimited combinations of BioBricks

with only a small set of primers, empowering synthetic biology at resource-deprived laboratories (such as high schools and community colleges)[13].

The iGEM team at Alma College enjoys a significant amount of institutional support – both in terms of resources, faculty attention, and promotion/celebration. The administration of Alma College is dedicated to what iGEM represents – an interdisciplinary, engaging experiential learning program. As a small liberal arts college, Alma prides itself on giving students unique experiences and an education that fosters a broad perspective – the type of perspective and skill set that is well suited for students to work with a diverse set of talented people on a multi-faceted project. Because iGEM projects are, at their core, focused on a problem and not a technique, they integrate many different disciplines together to not only design and develop their solution but to reflect upon and communicate it well. The administration at Alma rightly sees this mixture of challenges as a perfect complement to their established liberal arts curriculum. In addition to supporting students that are currently participating in iGEM, Alma College is keenly interested in efforts of outreach that will give high school and community college students a chance to visit or experience Alma. They are likely to provide material support for any league activities that fall under this umbrella, such as the meetup in September.

Likewise, the Alma College iGEM team themselves represent an important source of support for the foundation of a regional league. Since 2019, the team has been focused on spreading awareness of synthetic biology throughout Michigan. They have visited high schools, both local to Alma and in other locations throughout the state with demonstrations and promotions. The team is also active on social media and publishes a podcast known as Scot Science in which they promote the field. Not only do these activities help fulfill the education and outreach criteria for the Alma team, but the students are particularly engaged and excited by this work. As well-rounded students at a liberal arts college, Alma iGEMers recognize the importance of energetic and open communication for the emerging field of synthetic biology.

In addition to their outreach activities, the Alma iGEM team will serve as a mentorship resource for any participants in the regional league. They will also offer contract lab services and supplies for participating teams, for an additional cost. This optional part of the competition can be used to help address the more advanced criteria, and help to further enhance the educational experience for students participating in the league. Participating teams can order constructs from the Alma team at a base price of $10 and $2 per fragment used in assembly. For example, a simple assembly of 3 BioBricks together would cost a team $16, and would be delivered, sequence verified, within two weeks. This cost is possible due to the availability of the iGEM distribution kit, nearby sequencing resources, and the novel approach to Golden Gate assembly developed by Dr. Camenares and the Alma team[13].

Preliminary outreach work has already identified other educators and students that would be interested in a regional league for Michigan and the Great Lakes area. These include Mr.

Steven Lord, a teacher at Alma High School; Mr. Alan Gamble a teacher at Shepherd High School; Mr. Rick Cahoon, Shepherd High School Science Club Advisor; Dr. Eric Petersen, Assistant Professor at Central Michigan University, and Dr. Jeremiah Wagner, Professor at Mid-Michigan College.

The Gratiot-Isabella RESD, which oversees all public schools within those two counties, has also expressed interest and support. This group, and their counterparts for other regions in Michigan, will be instrumental in promoting and coordinating league activities across high schools. In early conversations with Dr. Kathy Peasely, Associate Superintendent for Instruction; Dr. Claire Bunker, MiSTEM Network Director - East Central Michigan Region, and several school principals, they saw the potential benefits an iGEM experience could bring for their students, but worried about the high costs and laboratory requirements for the international competition. They were excited by the prospect of getting a similar experience with much lower barriers to entry, and this feedback is incorporated into the cost structure and medal criteria for the league.

We also reached out to other local and state government groups for feedback and to form partnerships. This has included Megan Schrauben, Executive Director or the MiSTEM Network in the Michigan Department of Labor and Economic Opportunity, and Jeremy Hendges when the same office was known as the Department of Talent and Economic Development. Preliminary conversations with this department, as well as the Michigan Independent Colleges & Universities organization, were positive and receptive to the idea. They saw the opportunity for partnership and would help coordinate promotion efforts to different colleges that have not yet explored participation in iGEM.

One potential partnership that has not yet been developed is with the MichBio group, a biotechnology and pharmaceutical industry organization for relevant companies and institutions in the state. Currently, we are seeking membership in this group and an opportunity to join the Workforce and Education committee, from which we can better coordinate outreach to different colleges and schools. It is also our hope that this partner can provide some sponsorship or financial support to help us enhance the program.

Comparison with other Leagues

	Design League	Indian League	Great Lakes League
Most recent fee and costs	$1,500	$75	$60 – Proposed Entry fee $15 per person for attendance at meetup Other optional costs for constructs
Bronze Requirements	Team Forms; Participate in iGEM Academy; Project Videos; Proposal in JOGL; Design Roadmap	Judging Canvas, Wiki/JOGL, Video, Notebook/Whitepaper	Workshop, Presentation, Projection Description, Attribution & Impacts

Silver Requirements	Collaboration; Human Practices; Science Communication; Computational Biology	Biosafety Analysis, Integrated Human Practices, Engineering and Design, Proposed Implementation	Proposed Design, Outreach/Education, Safety, Human Practices (complete 3 of 4)
Gold Requirements	MANDATORY: Excellence in Engineering; Integrated Human Practices; Solving a Local Problem. OPTIONAL (Need 2): Science Communication; Partnership; Public Policy; Entrepreneurship; Diversity; Arts and Creativity; Biosafety	Choose 2 * Impact Analysis and Modelling * Entrepreneurship OR Outreach * Science Communication	Choose 2: Modeling, Entrepreneurship, Integrated Human Practices, or Contribution
Tracks	Environment & Biodiversity; Manufacturing and Biomaterials; Tools and Foundational Advances; Animal Health; Human health and biomedicine; Agriculture food and nutrition; Energy; Open Projects		
Awards	Presentation; Circuit Design; Infographic; Trailer video; Implementation; Biosafety; Human Practices; Computational Biology; Innovation; Arts and Creativity; Diversity; Local Heroes; Vision; Team Choice; SDG Impact; Policy and Regulation		Best Individaul, High School, Community College, and 4-year institution
2021 Participants	25 teams from 8 countires, 480 students. 10 Gold, 10 Silver, 5 Bronze.		
2022 Participants	22 Teams, results in 3 days!		
Calendar		Registration July 9-30, Training Aug1-Sep2, Judging Dec	Registration by March 1st, Meetup in September, Final work due in Dec

The Great Lakes Seasonal Challenge

This is intended to provide an experience similar to BioBuilder's Idea Accelerator, but the idea is that it can be individuals or small teams without a formal mentor.

Individuals can earn a Bronze, Silver, or Gold Medal. There will be some sort of small prize for Gold Medal (perhaps enter into a lottery for some prize) plus a prize for top entry, if resources permit.

For this Summer Challenge, one or more students or individuals at a high school, community college, or other higher education institution will need to write an essay that defines a problem and outlines a synthetic biology solution. It is a smaller version of the larger, longer, team based competition. This is designed so as to be an essay that will be featured on the GLSB website, and not require particular supervision.

Bronze Medal: Complete

- Project Description – You have defined **a local problem** and highlighted its importance. You have also identified what current solutions exist or have been proposed, and provided rationale for why synthetic biology solutions are advantageous.

Silver Medal: Complete 2 out of the Following 3 Criteria

- Proposed Design – You clearly shown how you will use **Synthetic Biology** to solve this problem, clearly indicating the DNA parts you would use, why they have been selected, how they will interact, and given an outline of how they are to be assembled and tested.
- Safety – You have proposed ways in which your project could be implemented safely and ethically. This could include the design or incorporation of an appropriate safety or kill-switch, or some other recognition of the risks involved in the project.
- Human Practices – You have considered the broader social, ethical, economic, or political ramifications for your project, and put your project in proper context amongst these issues. This can be based solely on research and reflection – incorporation of outreach and feedback into this process is encouraged and qualifies for the Integrated Human Practices criteria.

Gold Medal: Complete All Silver Medal and 1 out of the Following Criteria

- Mathematical Modeling – You have refined your proposed design and created a mathematical model of how some aspect of it should behave. You have **drawn a conclusion** from your model that can help provide insights into your project design.
- Integrated Human Practices - You have clearly shown how your outreach has informed your outlook on the issue, and the proposed design. You **have integrated**

feedback you received into your project in a significant way. This is where the "outreach" meets "inreach"! To qualify for this criteria, your outreach must also impact group(s) that total to at least double the size of your team.

- Outreach, Communication, or Education – You have engaged in well-documented outreach, to help raise awareness of your problem or to educate the broader community about synthetic biology. This can take many forms, but must all involve some interaction with stakeholders or community members from outside your group. You must **document and quantify** your impact – how many people were involved in this outreach?

Timeline:

I would envision running this during two different times – Winter and Summer. It should both complement existing programs (like iGEM and BioBuilder) as well as fill in the gaps for each.

The timeline should co-incide with the solstice and equinox. Thus, summer challenge is June 21st to September 23rd, while the winter challenge (identical setup) is from December 21st to March 20th (roughly).

The first date of the competition is the registration deadline, or a kick-off event, or some other such milestone. There should be at least one mentorship meeting in between, and a symposium to present the work.

References

1. Michigan Water Quality Issues. https://miwaterstewardship.org/michigan-water-issues/#:~:text=From%20microplastic%20pollution%2C%20contaminated%20drinking,Michigan%20has%20it's%20hands%20full.
2. CDC, National and State Diabetes Trends. https://www.cdc.gov/diabetes/library/reports/reportcard/national-state-diabetes-trends.html
3. NIH, NCI State Cancer Profiles. https://www.statecancerprofiles.cancer.gov/incidencerates/index.php?stateFIPS=00&areatype=state&cancer=001&race=00&sex=0&age=001&stage=999&year=0&type=incd&sortVariableName=rate&sortOrder=default&output=0#results
4. CDC, Heart Disease Mortality by State. https://www.cdc.gov/nchs/pressroom/sosmap/heart_disease_mortality/heart_disease.htm
5. JNIVSTATS, College Statistics by States. https://www.univstats.com/states/
6. My College Selection, Michigan. https://mycollegeselection.com/colleges-by-state/colleges-in-michigan/
7. JNIVSTATS, Michigan Colleges Student Population. https://www.univstats.com/states/michigan/student-population/
8. US News and World Report, University of Wisconsin--Madison. https://www.usnews.com/best-colleges/university-of-wisconsin-3895#:~:text=University%20of%20Wisconsin%E2%80%94Madison%20is,campus%20size%20is%20936%20acres.
9. Discover Milwaukee Relocation Guide. https://www.discovermilwaukee.com/learn/colleges-universities#:~:text=Colleges%20%26%20Universities,year%20schools%20serving%20the%20region
10. US News and World Report, University of Toledo. https://www.usnews.com/best-colleges/university-of-toledo-3131#:~:text=Overview,campus%20size%20is%201%2C037%20acres
11. Wikipedia, City Colleges of Chicago. https://en.wikipedia.org/wiki/City_Colleges_of_Chicago
12. MI School Data, Enrollment Counts Report. https://www.mischooldata.org/student-enrollment-counts-report/
13. Bower C, Harbin C, Camenares D. GEM-Gate: A Low-Cost, Flexible Approach to BioBrick Assembly. DNA. 2023; 3(1):33-40. https://doi.org/10.3390/dna3010003
14. National Center for Education Statistics. https://nces.ed.gov/collegenavigator/?s=MI&ct=1+2+3