



Evaluation Report

Investigative Workshop: Modeling

Toxoplasma gondii

May 13-15, 2010

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Workshop Evaluation Executive Summary

Brief Synopsis of Event

This report is an evaluation of a NIMBioS Investigative Workshop entitled “Modeling *Toxoplasma gondii*,” (*T. gondii*) which took place at NIMBioS May 13-15, 2010. NIMBioS Investigative Workshops are relatively large (30-40 participants), focus on a broader topic or a set of related topics than Working Groups, attempt to summarize/synthesize the state of the art and identify future directions, and have potential for leading to one or more future Working Groups. Participants may include post-docs and graduate students with less experience in the particular topic than those participating in Working Groups.

The *T. gondii* Workshop comprised 45 participants, including co-organizers Xiaopeng Zhao (Biomedical Engineering Dept., University of Tennessee, Knoxville), Jitender P. Dubey (Laboratory of Parasitic Diseases, United States Department of Agriculture), Jaewook Joo (Department of Physics and Astronomy, University of Tennessee, Knoxville), Michel Langlais (Institut Mathematiques de Bordeaux, Universite Victor Segalen Bordeaux), Suzanne Lenhart (NIMBioS Associate Director for Education and Outreach; Department of Mathematics, University of Tennessee, Knoxville), and Chunlei Su (Department of Microbiology, University of Tennessee, Knoxville). Participants included a diverse collection of biologists, chemists, computer scientists, engineers, mathematicians, and veterinary and health scientists in addition to several federal government employees.

The focus of the Workshop was to explore mathematical tools and problems in describing the life cycle, stage conversion, and clonal expansion of *Toxoplasma gondii* (a pervasive parasite known for its ability to infect a wide range of hosts), as well as exploring various modeling and analysis methods for their potential applications in public health strategies, and in the diagnosis, suppression, and prevention of Toxoplasmosis (the parasitic disease caused by *T. gondii*).

Evaluation Design

An electronic survey aligned to the following evaluation questions was designed by NIMBioS' Evaluation Coordinator with input from the NIMBioS Director and Deputy Director:

1. Were participants satisfied with the Workshop overall?
2. Did the meeting meet participant expectations?
3. Do participants feel the Workshop made adequate progress toward its stated goals?
4. Do participants feel they gained knowledge about the main issues related to the research problem?
5. Do participants feel they gained a better understanding of the research across disciplines related to the Workshop's research problem?
6. What impact do participants feel the Workshop will have on their future research?

7. Were participants satisfied with the accommodations offered by NIMBioS?
8. What changes in accommodations, group format, and/or content would participants like to see at future similar meetings?

An electronic survey aligned to the evaluation questions was designed by the NIMBioS Evaluation Coordinator with input from the NIMBioS Director and Deputy Director. The final instrument was hosted online via the University of Tennessee's secure online survey host mrlInterview. Links to the survey were sent to 27 registered Workshop participants on May 20, 2010 (co-organizers Xiaopeng Zhao, Jitender P. Dubey, Jaewook Joo, Michel Langlais, Suzanne Lenhart, and Chunlei Su, along with NIMBioS affiliates Folashade Augusto, Sharon Bewick, Vitaly Ganusov, Michael Gilchrist, and Agricola Odoi were not included in the evaluation). Reminder emails were sent to non-responding participants on May 27 and June 3, 2010. By June 12, 2010, 27 of the registered participants had given their feedback, for a response rate of 100%.

On May 27, 2010, seven participants who were reported to have attended the Workshop, but were not in the original registration roster, were also sent the evaluation survey. Reminder emails were sent to these seven participants on June 3 and June 7, 2010. By June 10, 2010, all seven of these participants had given their feedback for an overall response rate of 100%.

An electronic demographics survey aligned to the reporting requirements of the National Science Foundation was designed by NIMBioS' Evaluation Coordinator with input from NIMBioS' Director. The final instrument was hosted online via the University of Tennessee's online survey host mrlInterview. Links to the survey were sent to the 28 conference participants who had not previously attended a NIMBioS event on April 19, 2010. Reminder emails were sent to non-responding participants on April 26 and 29, 2010. By May 5, 2010, 28 participants had filled out the survey for a response rate of 100%. Demographic questions regarding gender, race, and ethnicity, and disability status were optional (disability status is not reported in this evaluation report). All demographic information is confidential, and results are reported only in the aggregate. When feasible, the evaluator filled in missing demographic data from other sources (e.g. address, institution, field of study). The evaluator did not assume race, ethnicity, or disability status for any participant who did not report this information.

Highlights of Results

- Overall satisfaction with the Workshop was high among respondents, the majority of whom indicated they either agreed or strongly agreed that the Workshop was very productive (88%) and met their expectations (91%).
- 100% of respondents thought the presentations were useful and that the presenters were very knowledgeable about their presentation topics, while 88% agreed the group discussions were useful.
- 100% of respondents either agreed or strongly agreed that they would recommend participating in NIMBioS Workshops to their colleagues.
- Overall, respondents reported being satisfied with the travel, housing, and other amenities provided by NIMBioS.
- Respondents reported relatively high levels of learning, with an average of 80% of respondents agreeing that they acquired new knowledge about the central topics of the workshop.
- Most respondents said the multidisciplinary composition of the Workshop was its most useful aspect.
- 100% of respondents said they felt that participating in the Workshop helped them understand the research going on in other disciplines regarding *T. gondii*.
- 81% of respondents agreed that the Workshop made adequate progress toward finding a common language across disciplines for research on the workshop's topic.
- 100% of respondents agreed that the format of the Workshop was very effective for achieving its goals.
- Several respondents said they felt that the exchange of ideas that took place during the Workshop would (or potentially would) initiate and/or influence their future research.
- Several respondents reported they developed solid plans for collaborative research with other Workshop participants, while others indicated they saw potential for collaboration in the future.

Conclusions and Recommendations

Overall, the Workshop was successful in making progress toward its goals. Survey respondents were satisfied with the meeting, indicating that it was a productive experience that met their expectations. Several indicated that the workshop organizers did a great job, and that progress was made towards understanding the research problems at hand. Respondents were also satisfied with the travel, housing, and other amenities offered by NIMBioS.

Respondents reported relatively high levels of learning about the central topics of the workshop. While the majority of respondents agreed that they had a better understanding of the main issues related to *T. gondii*, a few respondents said they either did not gain understanding, or felt “neutral” or about the amount of understanding they gained on the topics, while a small number disagreed that they learned anything about these topics.

Most respondents agreed that the Workshop made adequate progress toward finding a common language across disciplines for research on the workshop's topic, though some indicated more discussions need to be had before a real common language can be defined. All respondents agreed that participating in the Workshop helped them better understand the research going on in disciplines other than your own regarding *T. gondii*.

Several respondents said they felt that the exchange of ideas that took place during the Workshop would (or potentially would) initiate and/or influence their future research. In addition to new ideas for research, several respondents also said that they developed unanticipated plans for collaborative research with other Workshop participants, while others said the potential for collaboration was present.

Several suggestions for improvement of future workshops were suggested by participants, including more talks about the modeling aspect of *T. gondii*. Several respondents felt that more time devoted to discussion groups would have been beneficial as well. Other suggestions from respondents included more clarification of the goals of the workshop beforehand, and a tutorial before the workshop on mathematical models

Based on analysis of participant response data, the recommendations for future workshops are as follows:

- If feasible, consider offering a preconference webinar or other introductory materials to Workshop participants prior to the workshop to get those without a mathematical background up to date on the modeling aspects related to the research problems.
- Consider adding more breakout discussion time, and discuss the structure and objectives of the breakout groups prior to forming the groups.
- NIMBioS should discuss with the contracted hotel the problem of placing participants who have requested non-smoking rooms into smoking rooms.

Modeling *Toxoplasma gondii* Workshop Evaluation Report

Background

Introduction

This report is an evaluation of a NIMBioS Investigative Workshop entitled “Modeling *Toxoplasma gondii*,” (*T. gondii*) which took place at NIMBioS May 13-15, 2010. NIMBioS Investigative Workshops are relatively large (30-40 participants), focus on a broader topic or a set of related topics than Working Groups, attempt to summarize/synthesize the state of the art and identify future directions, and have potential for leading to one or more future Working Groups. Participants may include post-docs and graduate students with less experience in the particular topic than those participating in Working Groups.

The Modeling *Toxoplasma gondii* Investigative Workshop comprised 45 participants, including co-organizers Xiaopeng Zhao (Biomedical Engineering Dept., University of Tennessee, Knoxville), Jitender P. Dubey (Laboratory of Parasitic Diseases, United States Department of Agriculture), Jaewook Joo (Department of Physics and Astronomy, University of Tennessee, Knoxville), Michel Langlais (Institut Mathematiques de Bordeaux, Universite Victor Segalen Bordeaux), Suzanne Lenhart (NIMBioS Associate Director for Education and Outreach; Department of Mathematics, University of Tennessee, Knoxville), and Chunlei Su (Department of Microbiology, University of Tennessee, Knoxville). Participants included a diverse collection of biologists, chemists, computer scientists, engineers, mathematicians, and veterinary and health scientists in addition to several federal government employees.

Workshop Background

T. gondii is considered one of the most successful parasites for its unusual ability to infect a wide range of hosts, including all mammal and bird species. Up to 11% of the human population in the U.S. and 20% worldwide are chronically infected. Toxoplasmosis can cause life-threatening encephalitis (inflammation of the brain) in immunocompromised persons such as AIDS patients, as well as recipients of organ transplants and cancer chemotherapy patients. Infection acquired during pregnancy may spread and cause severe problems to the fetus such as damages to the baby’s eyes, nervous system, skin, and ears. Toxoplasmosis also has significant effects on human and animal behavior, and may lead to neuropsychiatric disorders (e.g. schizophrenia).

T. gondii has a complex life cycle that involves multiple hosts and includes sexual and asexual replications. After ingestion by the hosts, sporozoites (the mobile, infective stage of certain protozoa) rapidly differentiate into tachyzoites (fast-replicating parasites which disseminate within the host and lead to the acute phase of infection). Most of tachyzoites are eliminated by the innate and adaptive cell-mediated immune responses of immunocompetent hosts, but some differentiate into the dormant bradyzoites (a sessile, slow-growing form of the parasite) which are harder for the body to expunge.

The morph from tachyzoite to bradyzoite plays an indispensable role in the development of tissue cysts, and, thus, in the life-long persistence of parasites in the host. *T. gondii* has high genetic diversity, with

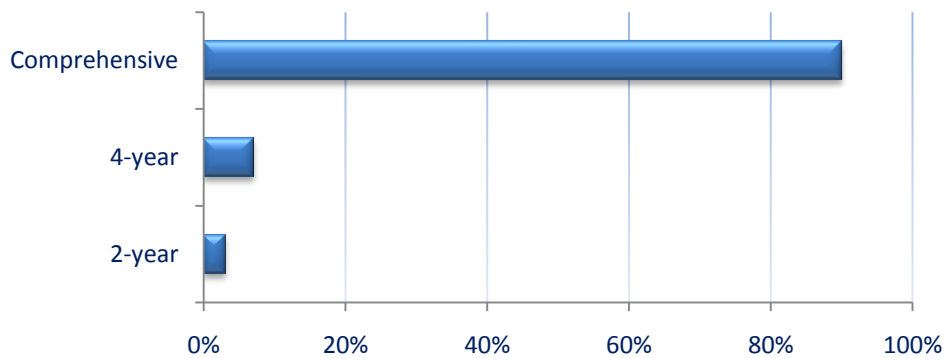
hundreds of genotypes existing globally. Only one lineage (type II), however, is widespread and predominates in the global populations.

Participant Demographics

Program participants were business/industry employees (3%), college/university faculty or staff (45%), graduate students (23%), government employees (7%), non-profit employees (2%), or postdoctoral researchers (13%) who came from 27 institutions across Brazil, China, Colombia, France, Mexico, Nigeria, and the United States. Within the United States, 16 different states were represented.

Of the 38 colleges/universities, 3% were classified as 2-year institutions, 7% as four-year institutions, and the remaining 90% as comprehensive institutions (Figure 1).

Figure 1. Classification of institutions (n =38)



Primary fields of study for the 45 participants included agricultural sciences/natural resources, biological/biomedical sciences, chemistry, computer & information sciences, engineering, health sciences, and mathematics (Table 1).

Table 1. Participant fields of study and areas of concentration

Field of Study	Concentration	# Participants
Agricultural Sciences/Natural Resources	Animal Science, Other	2
	Natural Resources/Conservation	1
Biological/Biomedical Sciences	Biomedical Sciences, Other	1
	Biotechnology	1
	Ecology	1
	Evolutionary Biology	2
	Immunology	1
	Mathematical Biology	1
	Mathematical Ecology	1
	Microbiology	4
	Molecular Biology	1
	Parasitology	5
	Zoology, Other	1
Chemistry	General	1
Computer & Information Sciences	Computer & Information Sciences, Other	1
	Computer Science	1
Engineering	Bioengineering & Biomedical	2
Health Sciences	Epidemiology	4
	Health Sciences, General	2
	Veterinary Medicine	1
Mathematics	Not Reported	2
	Applied Mathematics	4
	Mathematical Biology	4
	Number Theory	1

The 18 females and 27 males (six of whom self-identified as being of Hispanic/Latino ethnicity) mostly self-identified racially as white (Figures 2 & 3).

Figure 2. Ethnic composition of program participants (n =45)

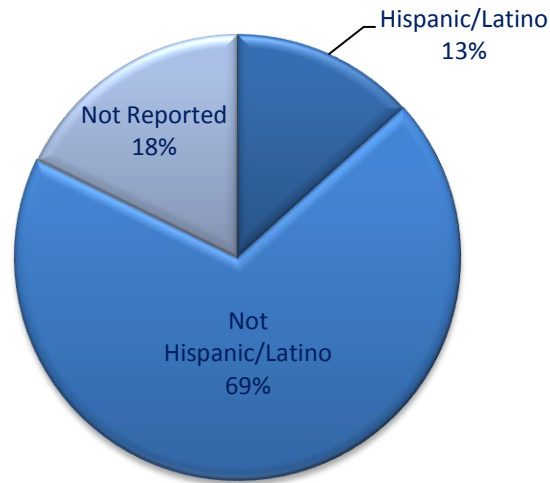
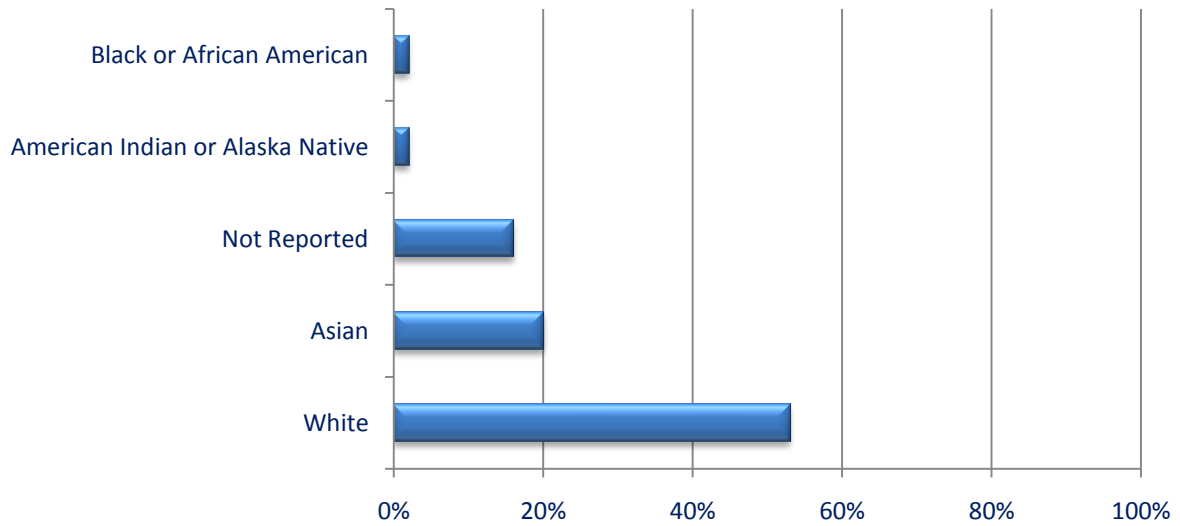


Figure 3. Racial composition of program participants (n =45)



One respondent indicated his/her work is currently supported by a National Science foundation grant (Table 2).

Table 2. NSF grants supporting participant research

Name of grant	Institution(s) at which grant is held
Ecology of Infectious Disease (EID)	University of California, Davis

Evaluation Design

Evaluation Questions

The evaluation of the Workshop was both formative and summative in nature, in that the data collected from participants was intended to both gain feedback from participants about the quality of the current Workshop and also to inform future meetings. The evaluation framework was guided by Kirkpatrick's Four Levels of Evaluation model for training and learning programs (Kirkpatrick, 1994¹). Several questions constituted the foundation for the evaluation:

1. Were participants satisfied with the Workshop overall?
2. Did the meeting meet participant expectations?
3. Do participants feel the Workshop made adequate progress toward its stated goals?
4. Do participants feel they gained knowledge about the main issues related to the research problem?
5. Do participants feel they gained a better understanding of the research across disciplines related to the Workshop's research problem?
6. What impact do participants feel the Workshop will have on their future research?
7. Were participants satisfied with the accommodations offered by NIMBioS?
8. What changes in accommodations, group format, and/or content would participants like to see at future similar meetings?

Evaluation Procedures

An electronic survey aligned to the evaluation questions was designed by the NIMBioS Evaluation Coordinator with input from the NIMBioS Director and Deputy Director. The final instrument was hosted online via the University of Tennessee's secure online survey host mrlInterview. Links to the survey were sent to 27 registered Workshop participants on May 20, 2010 (co-organizers Xiaopeng Zhao, Jitender P. Dubey, Jaewook Joo, Michel Langlais, Suzanne Lenhart, and Chunlei Su, along with NIMBioS affiliates Folashade Augusto, Sharon Bewick, Vitaly Ganusov, Michael Gilchrist, and Agricola Odoi were not included in the evaluation). Reminder emails were sent to non-responding participants on May 27 and, June 3, 2010. By June 12, 2010, 27 of the registered participants had given their feedback, for a response rate of 100%.

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¹ From Kirkpatrick, D.L. (1994). *Evaluating Training Programs: The Four Levels*. San Francisco, CA: Berrett-Koehler.

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Data Analysis

Data from the electronic survey included both forced-response and supply-item questions. All data were downloaded from the online survey host into the statistical software package SPSS for analysis. Quantitative data were analyzed using SPSS, while qualitative data were analyzed in SPSS Text Analysis for Surveys. Qualitative responses were categorized by question and analyzed for trends.

Findings

Overall Satisfaction

Overall satisfaction with the Workshop was high among respondents, the majority of whom indicated they either agreed or strongly agreed that the Workshop was very productive (88%) and met their expectations (91%). Some general participant comments:

"The workshop was a very positive experience for me and I truly appreciate that you encourage graduate students attending by providing vital travel support. I interacted with so many excellent researchers and will incorporate information from the group discussions as well as my personal interactions into my research plans. Thank you for this opportunity."

"I am grateful for this opportunity. I thank the organizers of this workshop for this opportunity to participate and learn so much."

"Thanks for the workshop. It was very useful for me. Hope to continue my participation via a working group, if one takes shape along lines of my interests and expertise."

All respondents thought the presentations were useful and that the presenters were very knowledgeable about their presentation topics, while most (88%) agreed the group discussions were useful. Additionally, all of the respondents either agreed or strongly agreed that they would recommend participating in NIMBioS Workshops to their colleagues (Table 2).

Table 3. Participant satisfaction with various aspects of the Workshop

	<i>n</i>	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I feel the Workshop was very productive.	34	44%*	44%	8%	3%	0%
The Workshop met my expectations.	34	35%	56%	6%	3%	0%
The presenters were very knowledgeable about their topics.	34	88%	12%	0%	0%	0%
The presentations were useful.	34	68%	32%	0%	0%	0%
The group discussions were useful.	33	42%	46%	9%	3%	0%
I would recommend participating in NIMBioS Workshops to my colleagues.	33	55%	45%	0%	0%	0%

* Note: Percentages in tables may not add to 100% due to rounding

Satisfaction with Accommodations

Overall, respondents reported being satisfied with the travel, housing, and facilities provided by NIMBioS during the Workshop. Participant comments about the overall accommodations:

“No problems. We are there to work and collaborate and the conditions were certainly adequate for that.”

“Excellent options for food and lodging...thank you!!”

“Great job!”

One participant did, however, indicate that the Holiday Inn was not a good choice of hotel:

“The Holiday Inn was a very bad choice for me: they put me in a smoking room that smelled as it should and also there was a dog show of some sort in town of which I have several participants barking until late night in my floor.....No availability of rooms to make changes.”

Twenty-four respondents answered questions regarding satisfaction with travel, 22 of whom said they were satisfied with their accommodations, while one indicated feeling “neutral” and one was dissatisfied. The dissatisfied participant did not give reasons for feeling so.

The majority of participants reported being satisfied with the comfort and resources of the NIMBioS facility, as well as the quality of meals provided (Table 3).

Table 4. Participant satisfaction with Workshop accommodations

Please indicate your level of satisfaction with the Workshop accommodations:	<i>n</i>	Very satisfied	Satisfied	Neutral	Dissatisfied	Strongly dissatisfied	Not applicable
Travel arranged by NIMBioS	32	56%	13%	3%	3%	0%	25%
Housing arranged by NIMBioS	32	59%	13%	3%	3%	0%	22%
Comfort of the facility in which the Workshop took place	33	73%	27%	0%	0%	0%	0%
Resources of the facility in which the Workshop took place	33	70%	30%	0%	0%	0%	0%
Quality of meals	32	50%	31%	9%	3%	0%	6%
Quality of drinks and snacks provided	33	55%	39%	3%	3%	0%	0%

Workshop Content and Format

Participant Learning

All respondents said they felt that participating in the Workshop helped them understand the research going on in other disciplines regarding *T. gondii*. Respondents were also asked several questions to gauge their levels of learning about the main issues related to the research problem, including learning about the mathematical tools available for explaining the life cycle, stage conversion, and clonal expansion of *T. gondii*; the research data available on *T. gondii*; and the applications of modeling and analysis methods in diagnosis, suppression, and prevention of *T. gondii*.

Respondents reported relatively high levels of learning, with an average of 80% of respondents agreeing that they learned more about the central topics of the workshop. While the majority of respondents agreed that they had a better understanding of the main issues related to *T. gondii*, some respondents said they either did not gain understanding, or felt “neutral” or about the amount of understanding they gained on the topics, while a small number strongly disagreed that they learned anything about these topics (Table 5). Respondents who disagreed that they learned about modeling and analysis methods had this to say:

“...I came away with a better idea of modeling applications, but not as strong as I had hoped.”

“My biggest complaint was that there was so little presented about modeling. I think it would have been very helpful for all of the biologists to really understand how modeling works. I feel

like the mathematicians in the room learned a lot about Toxo but we didn't really learn nearly as much about modeling. The last discussion as a big group really seemed to point that out; many of the biologists were still asking what the modelers thought was most interesting and able to be a good model, and I feel like we should have been able to talk to them much more intelligently about our ideas. Just as there was a number of VERY general Toxo talks, there should have also been general talks on what modeling is, how it is used in other systems, what goes into it, and what questions are good to ask. I also think that we could have had a talk on an overview of models that have worked in other infectious disease systems so that we had a place to start."

Table 5. Participant learning in areas related to the Workshop’s research problem

As a result of participating in this Workshop, I have a better understanding of:	<i>n</i>	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The mathematical tools available for explaining the life cycle, stage conversion, and clonal expansion of <i>T. gondii</i>	34	29%	44%	24%	3%	0%
The research data available on <i>T. gondii</i>	32	56%	34%	9%	0%	0%
The applications of modeling and analysis methods in diagnosis, suppression, and prevention of <i>T. gondii</i>	34	24%	53%	18%	6%	0%

Most Useful Aspects

Ninety-four percent respondents felt the Workshop format was effective. One respondent had this to say about the format:

“The program was not jam-packed with presentations, and allowed lots of time between presentations and group discussions, for informal interactions and discussions. This format is tremendously valuable and in contrast to many meetings these days. The give-and-take allowed during the presentations was also a positive.”

Several respondents felt the most useful aspect of the Workshop was the ability network with a diverse group of researchers:

“You put mathematicians and biologists together and let them communicate and discuss the same topics. From all discussions, we know what others need and what we can do to understand the topics better. It is a good experience.”

“The diversity of participants, the time allowed for discussion and the relaxed setting in which individual conversations were possible and encouraged.”

“All of the dialogue between so many people with so many different backgrounds; really fantastic!”

“It was a great mix of biology and mathematics.”

Other respondents felt the break-out group discussions were the most useful aspect of the Workshop:

“Probably the small group discussions and generally the smaller and more focused the better - in my experience a small group discussion with 5-6 after the meeting before people left.”

“The hi-functioning, high energy breakout sessions were the most useful aspect of the workshops. Since they were punctuated by the talk, it was easy to pick up where the researchers left off. These sessions had a think-tank like feel to them. I learned a great deal during these sessions.”

Many respondents said the actual material presented during the Workshop was its most useful aspect:

“The workshop served as a good review of the biology of Toxoplasma from epidemiological aspects, to the immune response and dynamics of intracellular infection to cell and molecular aspects of the host/parasite infection. Considering this large overview of Toxoplasma biology from a mathematical/modeling view was informative and caused me to think about some of my studies from a different perspective and with different questions in mind.”

“Having all biological and epidemiological information together within two days of the workshop was helpful and useful.”

“The most useful was the wide array of T. gondii research topics introduced and discussed.”

“The last discussion on Saturday morning; you began to feel that the biologists began to understand and appreciate what modeling could do for them. It was somewhat exciting to see.”

Communication

Thirty-three of the 34 survey respondents said they were either “very satisfied” or “satisfied” with the opportunities provided during workshop presentations and discussions to ask questions and/or make comments. Several respondents gave suggestions for facilitating communication among participants during the workshop, the most common of which was to have more time in smaller discussion groups:

“On this topic at least, smaller group discussion time would have been helpful to identify specific topics for working groups.”

“The smaller workgroups were useful and held the beginnings of productive exchanges between the mathematicians and the biologists. I think a little more time in these groups was needed even at this initial meeting.”

“Even smaller groups and more guidance of types of applications would be helpful. Maybe even before arriving a brief tutorial of the pathogen and some idea of the questions mathematicians would like to address.”

Other suggestions included the inclusion of a short poster session, and reserving a time for student questions:

“A short poster session, with beverages/snacks, on one of the days will provide more results to look at, and a more concrete medium for further discussion.”

“Might be a way to nudge students to participate more. Reserving a time for their questions, perhaps?”

Progress Toward Goals

Eighty-one percent of respondents agreed that the Workshop made adequate progress toward finding a common language across disciplines for research on the workshop's topic:

“This common language was mostly found during group discussions, so interactive processes are of overwhelming importance.”

*“The mathematicians gained insight into the *T. gondii* system, and in turn, convinced the biologists of the usefulness of modeling this system. Examples are healthy discussions on the strengths and limitations of the experimental data, and an agreement from both groups that linking models describing within-host pathogen dynamics and between-host pathogen dynamics is a valuable endeavor. Although such a project would not be trivial and may justify a working group.”*

“Although I think there were initially some challenging language areas, the conversation did cross the math/bio boundary to allow for effective communication.”

Other participants felt that, while progress was made, more discussions need to be had before a real common language can be defined:

“I think that more discussions will be required after people begin to think about how biological observation can be quantified in a way that allows for quantitative assessment in a model. I also think that these discussions will help to identify those areas where modeling is truly needed, and where the results of modeling will advance our knowledge of the organism, pathogenesis and disease, rather than to model for the sake of modeling. Important questions should be identified first, then an assessment of whether modeling the related phenomena will help to answer the question.”

“The workshop provided me some ideas about how mathematical approaches could help biological approaches. However, I still feel that I do not know much about it. Probably, I need to do some actual work to understand how these two different approaches can assist each other to understand a complicated biological phenomenon.”

One-hundred percent of respondents agreed that participating in the Workshop helped them better understand the research going on in disciplines other than your own regarding *T. gondii*:

"I found that mathematical modeling is a very effective approach to addressing the problem of T. gondii related deaths. The mathematicians, epidemiologists, and the biological experts at this meeting helped me get a very good idea of research going on in related fields. Now, I believe I can modify my approach to similar problems. Inviting researchers like Dr. Dubey, Dr. Rosenthal, Dr. Jorge Velasco-Hernandez, Dr. Radke, and Dr. Gilot-Fromont has been very helpful and this was the crash course I needed in the current research in T. gondii."

"...My improved understanding of the wildly successful generalist pathogen, T. gondii, will surely aid my own research in the generalist pathogen, B. burgdorferi. Furthermore, I was able to establish contacts with experts whom are willing to assist my research efforts. I look forward to developing these collaborations, and I will keep a close eye on the future activities of NIMBioS. Much thanks to the NIMBioS team."

"The balance between scientists having a comprehensive ecological and epidemiological knowledge of the dynamics of T. gondii through a network of successive hosts and at the intrahost scale, and modelers using mathematical or computerized methodologies -- including IBM systems and GIS technology -- was perfectly tuned."

Several biologists in attendance noted, however, that more background or introductory information about modeling would have been helpful:

"I am not sure whether non-modeler biologists had a sufficient background on what modeling is. Maybe it would have been useful to make a very general, introductory talk on what models do and how. This would allow them to be able to view their own research subject in a modeling perspective, not to do models by themselves but to be more able to interact with modelers."

"There seemed to be more talks on the biology of T. gondii than modeling of the disease. It would probably be better if it included more modelers in the presentations."

Impact on Future Research Plans

Several respondents said they felt that the exchange of ideas that took place during the Workshop would (or potentially would) initiate and/or influence their future research. Some participant comments:

"This workshop has deeply impacted me. I was a biologist but now I am immensely interested in mathematical modeling."

"A particular topic regarding the presumed clonal expansion of the type II strain of T. gondii is somewhat unresolved due to the question of whether natural selection is driving the predominance of type II, or is type II more common because it is the most ancestral type. I believe this question is likely to surface in different pathogen systems, and a multi-faceted approach is likely required for resolution. One approach is dating the divergence times of related strains, and I intend to incorporate dating in my future research in pathogen systems."

"It gave me clearer ideas of which axes to develop in the modeling process."

In addition to new ideas for research, several respondents also said that they developed unanticipated plans for collaborative research with other Workshop participants, while others said the potential for collaboration was present:

“My joint work on within-host between host interactions was enriched and we got new ideas. We are writing a paper on that already.”

“Work to measure local area biochemistry around a tissue cyst in a mouse brain will be completed by laser micro-dissection and transcriptional profiling--in conjunction with Yasihuro Suzuki.”

“I am a biologist and I did discuss potential new collaborative research with other biologists. However, I felt we just scratched the surface in exploring mathematical and modeling applications, and weren't able in the time available to identify research problems that may be amenable to modeling solutions.”

“...Dr. Michael Gilchrist gave useful explanations into modeling the Borrelia system. I asked if he would be willing to provide future assistance and he agree. I intend to contact him within one or two months.”

Suggestions for Future Workshop Meetings

Respondents were asked several questions soliciting suggestions for future Workshop meetings. Several themes emerged from analysis of participant responses, including more talks about the modeling aspect of *T. gondii*:

“Again, more general talks on math modeling. The only talks that we had were very specific models, which were useful and interesting, but I would have appreciated a more general introduction to math modeling and how it is used in other systems, etc.”

“Bring more on modeling.... Maybe try to really make them go into the modeling process, by proposing a small training where they would build and analyze a small model. I could have proposed such training, and probably for other workshops some modelers may do it for other subjects. [And] encourage discussions earlier in the process, so that participants may even go further in the modeling process before the end of the session: write a first model or begin to write the constraints to do it.”

“Present more mathematical results and more mathematical models.”

“Add a few lectures on the applications of mathematic modeling in biology. This will help biologists understand modeling even better.”

“I would allow the modelers to share more background on their approaches to encourage more dialogue with the biologists. I would build in more time for the breakout sessions and consider reducing the subject content of the workshop (even though Toxoplasma seems specific) as in modeling terms within host vs. between host modeling are quite different approaches.”

Several respondents felt that more time devoted to discussion groups would have been beneficial.

“It would have been nice to have more group discussion time.”

“More time for discussions: 1. what needs to be modeled and why? 2. More interaction across disciplines to better understand what mathematicians need e. g. type of observations and relative quantities.”

Several would have liked to have seen the existing discussion groups more organized as well:

“The discussion groups should have a designated moderator whose job is to keep ideas on track without suppressing valuable input from the participants, nor making participants feel excluded. This would be a delicate task.”

“The discussion groups, at times very chaotic.”

“More structure in the breakout sections, with some mechanism to enforce 'mixing' among disciplines; perhaps more assertive facilitation of such sessions.”

Other suggestions from respondents included more clarification of the goals of the workshop beforehand, and a tutorial before the workshop on mathematical models:

“The organizers did a good job of explaining the purpose of this meeting during the course of the workshop, but more clarity of the scope and purpose of the meeting beforehand would have been useful.”

“A brief tutorial on things mathematical models are useful for, how they can expand the usefulness of biological data and the types of data required would be helpful either before the meeting or at the beginning.”

Conclusions and Recommendations

Overall, the Workshop was successful in making progress toward its goals. Survey respondents were satisfied with the meeting, indicating that it was a productive experience that met their expectations. Several indicated that the workshop organizers did a great job, and that progress was made towards understanding the research problems at hand. Respondents were also satisfied with the travel, housing, and other amenities offered by NIMBioS.

Respondents reported relatively high levels of learning about the central topics of the workshop. While the majority of respondents agreed that they had a better understanding of the main issues related to *T. gondii*, a few respondents said they either did not gain understanding, or felt “neutral” or about the amount of understanding they gained on the topics, while a small number disagreed that they learned anything about these topics.

Most respondents agreed that the Workshop made adequate progress toward finding a common language across disciplines for research on the workshop's topic, though some indicated more discussions need to be had before a real common language can be defined. All respondents agreed that

participating in the Workshop helped them better understand the research going on in disciplines other than your own regarding *T. gondii*.

Several respondents said they felt that the exchange of ideas that took place during the Workshop would (or potentially would) initiate and/or influence their future research. In addition to new ideas for research, several respondents also said that they developed unanticipated plans for collaborative research with other Workshop participants, while others said the potential for collaboration was present.

Several suggestions for improvement of future workshops were suggested by participants, including more talks about the modeling aspect of *T. gondii*. Several respondents felt that more time devoted to discussion groups would have been beneficial as well. Other suggestions from respondents included more clarification of the goals of the workshop beforehand, and a tutorial before the workshop on mathematical models

Based on analysis of participant response data, the recommendations for future workshops are as follows:

- If feasible, consider offering a preconference webinar or other introductory materials to Workshop participants prior to the workshop to get those without a mathematical background up to date on the modeling aspects related to the research problems.
- Consider adding more breakout discussion time, and discuss the structure and objectives of the breakout groups prior to forming the groups.
- NIMBioS should discuss with the contracted hotel the problem of placing participants who have requested non-smoking rooms into smoking rooms.

Appendix A

List of Participants

Participants

Last name	First name	Institution
Agusto	Folashade	NIMBioS
Aranda Lozano	Diego Fernando	Universidad Del Tolima, Colombia
Arrizabalaga	Gustavo	University of Idaho
Banerjee	Jheelam	Vanderbilt University
Baroch	John	United States Department of Agriculture
Bewick	Sharon	NIMBioS
Casala	Hema	Texas Tech University
*Dubey	Jitender	United States Department of Agriculture
Feng	Zhilan	Purdue University
Ganusov	Vitaly	NIMBioS & Los Alamos National Laboratory
Gennari	Solange	University of Sao Paulo
Gerardo-Giorda	Luca	Emory University
Gilchrist	Michael	NIMBioS & University of Tennessee, Knoxville
Gilot-Fromont	Emmanuelle	VetAgro-Sup-Campus Veterinaire
Halonen	Sandra	Montana State University, Bozeman
Harris	William	Georgetown College
Haven	James	New Jersey City University
Hill	Rachel	University of Tennessee Knoxville
*Joo	Jaewook	University of Tennessee, Knoxville
Khan	Asis	Washington University, St. Louis
*Langlais	Michel	Victor Segalen Bordeaux 2 University
*Lenhart	Suzanne	NIMBioS
Loyd	Kerrie Anne	University of Georgia Athens
Majumdar	Debashree	University of Tennessee, Knoxville

Mazurie	Aurelien	Montana State University, Bozeman
Miller	Natalie	University of Pennsylvania
Mordue	Dana	New York Medical College
Ocampo	Lina	University of Quindio
Odoi	Agricola	NIMBioS
Plechac	Peter	University of Tennessee Knoxville
Qu	Daofeng	University of Tennessee Knoxville
Radke	Jay	Montana State University, Bozeman
Rosenthal	Benjamin	United States Department of Agriculture
Shwab	Elliot	University of Tennessee, Knoxville
*Su	Chunlei	University of Tennessee, Knoxville
Sullivan	Adam	University of Tennessee, Knoxville
Suzuki	Yasuhiro	University of Kentucky
Tian	Paul (Jianjun)	College of William and Mary
Van Wormer	Elizabeth	University of California, Davis
Velasco-Hernandez	Jorge	Programa de Matematicas Aplicadas y Computacion
Villena	Isabelle	University of Reims, Champagne-Ardenne
Wong	Kwai Lam	National Institute for Computational Sciences
Yang	Yiding	Purdue University
*Zhao	Xiaopeng	University of Tennessee, Knoxville
Zhou	Huaiyu	Not Reported

*** Organizer of Workshop**

Appendix B

Modeling Toxoplasma gondii Workshop Survey

Modeling *Toxoplasma gondii* Survey

Thank you for taking a moment to complete this survey. Your responses will be used to improve the Workshops hosted by the National Institute for Mathematical and Biological Synthesis. Information supplied on the survey will be confidential, and results will be reported only in the aggregate.

Workshop Evaluation

Please check the appropriate box to indicate your level of agreement with the following statements about this Workshop: (Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied)

- I feel the Workshop was very productive.
- The Workshop met my expectations.
- The presenters were very knowledgeable about their topics.
- The presentations were useful.
- The group discussions were useful
- I would recommend participating in NIMBioS Workshops to my colleagues.

Please check the appropriate box to indicate your level of agreement with the following statements. As a result of participating in this Workshop, I have a better understanding of:
(Strongly agree, Agree, Neutral, Disagree, Strongly disagree)

- mathematical tools available for explaining the life cycle, stage conversion, and clonal expansion of *T. gondii*
- the research data available on *T. gondii*
- applications of modeling and analysis methods in diagnosis, suppression, and prevention of *T. gondii*

Do you feel the Workshop made adequate progress toward finding a common language across disciplines for research on the workshop's topic?

Yes

No

Comments:

Do you feel that participating in the Workshop helped you better understand the research going on in disciplines other than your own regarding *T. gondii*?

Yes

No

Comments:

Do you feel that the exchange of ideas that took place during the Workshop will influence your future research? Please explain:

Did you develop unanticipated plans for collaborative research with other Workshop participants? Please explain:

What do you feel was the most useful aspect of the Workshop?

What would you have changed about the Workshop?

How do you feel about the format of the Workshop?

This was a very effective format for achieving our goals

This was not a very effective format for achieving our goals ->

The Workshop format would have been more effective if:

Please indicate your level of satisfaction with the Workshop accommodations:

(Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied, Not applicable)

Travel arranged by NIMBioS

Housing arranged by NIMBioS

Comfort of the facility in which the Workshop took place

Resources of the facility in which the Workshop took place

Quality of meals

Quality of drinks and snacks provided

Please indicate any changes NIMBioS can make to improve the resources and/or accommodations available to Workshop participants:

Communications Evaluation

NIMBioS is currently exploring innovative avenues for communication among its Workshop participants. Your responses to the following questions will allow us to better understand the communication needs of our scientific communities.

How satisfied were you with the opportunities provided during Workshop presentations and discussions to ask questions and/or make comments?

Very satisfied

Satisfied

Neutral

Dissatisfied

Very Dissatisfied

Please indicate any suggestions you have for facilitating communication among participants during the Workshop:

If you maintain a blog about your research and would like a link posted on the NIMBioS website, please provide the URL here, along with a brief description of the blog:

Please provide any additional comments about your overall experience with the Workshop:

Appendix C

Open-ended Survey Responses

Do you feel that participating in the Workshop helped you better understand the research going on in disciplines other than your own regarding *T. gondii*? Comments: (n=15)

I found it extremely helpful to have Toxo researchers from diversity of backgrounds (geneticists, immunologists, epidemiologists, etc) and multiple institutions involved in the conversation. I think the networking opportunities were excellent and the discussion much richer for having so many different opinions. I would have liked to have heard more from the mathematical modelers in general on tools available for disease modeling more broadly than Toxo. I think there was a lot of Toxo background for the modelers, but much less introductory material on modeling for the biologists.

Workshop was very interesting for better understand the research on modeling life cycle of *T. gondii*.

I don't know if modeling will provide useful information on *T. gondii* however, I have a better understanding of the type of data mathematicians need for modeling and the way they think through the process. I found the meeting useful primarily for the way it broadened my perspective.

IT WAS A VERY WELL ORGANIZED MEETING. ONLY I DID NOT UNDERSTOOD VERY WELL THE FOLLOW STEP OF THE MEETING.

Was very stimulating and I think it will lead to good collaborations., If I were to do anything different, it would be to discourage self-selection (by realm of expertise) in the breakout sessions...we had to recruit a mathematician to our group otherwise over-represented by 'bench' and 'field' biologists., Also- I regret having had to leave just a little early. So while the experience was great, I left without a sense of closure, or a clear sense of what 'working group' might emerge henceforth.

I am not a researcher in this field and cannot make any comments. , The workshop gave me a great overview some of the mathematical models about *T. gondii*.

The high level of expertise gathered for the workshop was remarkable and the presentations were very enlightening.

There seemed to be more talks on the biology of *T. gondii* than modeling of the disease. It would probably be better if it included more modelers in the presentations.

I was amazed to see the amount of information available on *Toxoplasma gondii*. I learnt a lot of tools for mathematical modeling and will be implementing it on my dataset

Although the mathematical part was sometimes hard to understand as a biologist, the marriage of the two gave another aspect to Toxo.

I found that mathematical modeling is a very effective approach to addressing the problem of *T. gondii* related deaths. The mathematicians, epidemiologists, and the biological experts at this meeting helped me get a very good idea of research going on in related fields. Now, I believe I can modify my approach to similar problems. Inviting researchers like Dr. Dubey, Dr. Rosenthal, Dr. Jorge Velasco-Hernandez, Dr. Radke, and Dr. Gilot-Fromont has been very helpful and this was the crash course I needed in the current research in *T. gondii*.

The stress in multidisciplinary team work and discussion and the balance between mathematically oriented and biologically oriented researches was optimal.

We had an up-to-date summary of research going on, in areas I am not familiar with. These allowed us to have a clear idea of what is known now and of questions remaining, which is the starting point to see which questions can be investigated through modeling or not. I am not sure whether non-modeler biologists had a sufficient background on what modeling is. Maybe it would have been useful to make a very general, introductory talk on what models do and how. This would allow them to be able to view their own research subject in a modeling perspective, not to do models by themselves but to be more able to interact with modelers.

I feel that the majority of the talks gave a beautiful overview of the topic presented. The only talks that were a little too detail oriented for me were the two talks on immunology. I think it would have been much more useful to have these talk be much more general talks about the immune response to Toxo...

I very much appreciated my attendance at this workshop. My improved understanding of the wildly successful generalist pathogen, *T. gondii*, will surely aid my own research in the generalist pathogen, *B. burgdorferi*. Furthermore, I was able to establish contacts with experts whom are willing to assist my research efforts. I look forward to developing these collaborations, and I will keep a close eye on the future activities of NIMBioS. Much thanks to the NIMBioS team.

I wish the organizer is open-minded.

I work at *T. Gondii*, and I think that the workshop reinforced my knowledge and interest in continuing working on it

The balance between scientists having a comprehensive ecological and epidemiological knowledge of the dynamics of *T. gondii* through a network of successive hosts and at the intrahost scale, and modelers using mathematical or computerized methodologies -- including IBM systems and GIS technology -- was perfectly tuned.

This is a great meeting for biologists (like myself) to look at our studies on biology from a very different perspective.

Do you feel the Workshop made adequate progress toward finding a common language across disciplines for research on the Workshop's topic? Comments: (n=12)

This common language was mostly found during group discussions, so interactive processes are of overwhelming importance.

The mathematicians gained insight into the *T. gondii* system, and in turn, convinced the biologists of the usefulness of modeling this system. Examples are healthy discussions on the strengths and limitations of the experimental data, and an agreement from both groups that linking models describing within-host pathogen dynamics and between-host pathogen dynamics is a valuable endeavor. Although such a project would not be trivial and may justify a working group.

Although I think there was initially some challenging language areas, the conversation did cross the math/bio boundary to allow for effective communication.

IN MY OPINION IT IS EASIER FOR THE SIDE OF MATHS TO UNDERSTAND THE SIDE OF BIOLOGY THAN THE OPPOSITE. IT IS NOT THEIR FAULT., IT IS NOT ENOUGH BASE FOR THE BIOLOGICAL SCIENTISTS TO ARGUE THEN ABOUT THEIR DOUBTS..

The workshop provided me some ideas about how mathematical approaches could help biological approaches. However, I still feel that I do not know much about it. Probably, I need to do some actual work to understand how these two different approaches can assist each other to understand a complicated biological phenomenon.

I think that more discussions will be required after people begin to think about how biological observation can be quantified in a way that allows for quantitative assessment in a model. I also think that these discussions will help to identify those areas where modeling is truly needed, and where the results of modeling will advance our knowledge of the organism, pathogenesis and disease, rather than to model for the sake of modeling. Important questions should be identified first, then an assessment of whether modeling the related phenomena will help to answer the question.

There was a lot of crosstalk across disciplines; great! My biggest complaint was that there was so little presented about modeling. I think it would have been very helpful for all of the biologists to really understand how modeling works. I feel like the mathematicians in the room learned a lot about Toxo but we didn't really learn nearly as much about modeling. The last discussion as a big group really seemed to point that out; many of the biologists were still asking what the modelers thought was most interesting and able to be a good model, and I feel like we should have been able to talk to them much more intelligently about our ideas. Just as there was a number of VERY general Toxo talks, there should have also been general talks on what modeling is, how it is used in other systems, what goes into it, and what questions are good to ask. I also think that we could have had a talk on an overview of models that have worked in other infectious disease systems so that we had a place to start.

I would like a lecture on the uses of mathematical models. I thought it was more about the Toxoplasma scientist explaining the biology to the mathematicians and I would have liked it to go the other way as well.

Not quite. Definitely we made good strides. But I think we perhaps needed just a bit more time to really claim such progress.

I think there remains a large disconnect but it was certainly a step in the right direction. We had an additional conversation after the meeting between a few mathematicians and parasitologists which was quite invigorating and productive. One talk by a mathematician of modeling reactions between predators and prey was particularly informative in terms of the thought process behind mathematical and particularly the idea that the reaction between the parasite and host immune cell might be viewed in a similar context.

I think the door was opened for dialogue but still a ways to go

The program was weighted too strongly toward the biology, without enough emphasis on the potential applications of modeling to moving the research forward. Also, there seemed to be a wide range of familiarity among the participants with Toxoplasma biology/ecology/genetics and modeling applications. There were a few people who clearly had a solid footing in both areas. Perhaps some introductory presentations by these experts would help everybody start with a basic understanding of the other discipline and help frame the following presentations and discussions. I suggest the program may have been more productive with fewer formal presentations and more small discussion group time. That said, the subject matter is enormously complex and the possible approaches very wide ranging. It was almost too broad a topic to address in three days. Hopefully the great networking that was facilitated by the workshop will be followed by formation of one or more working groups with a more narrow focus.

After the workshop, we did not receive any information as promised.

I think that the workshop had a adequate progress

This is a great starting point. We need to work together more in the future.

yes, also because many young people coming either from biological / medical sciences or mathematics spent a couple of days together asking many questions to senior researchers outside their own field of interest.

Do you feel that the exchange of ideas that took place during the Workshop will influence your future research? Please explain: (n=10)

Absolutely. Mathematical modeling seems something that will provide me with very effective solutions, in my research.

Absolutely. The venue was very conducive to asking probing questions and identifying areas fertile for future work.

For studies on modeling for T. gondii life cycle and dispersion of parasites in environment to assure transmission (I'm working with E Gilot on this aspect).

It gave me clearer ideas of which axes to develop in the modeling process.

This workshop has deeply impacted me. I was a biologist but now I am immensely interested in mathematical modeling

Again, primarily within the context of the biology of *Toxoplasma*. I came away with a better idea of modeling applications, but not as strong as I had hoped.

T. gondii is a fascinating disease from the point of view of complexity and data. This is the kind of problems where the interface between math and biology can be most productive

Not sure - it certainly made me more open and alert to new ideas and potential directions.

I always like looking at the big global picture, and too often I feel this isn't done by researchers. It was really interesting to have so much time to talk about such theoretical ideas!

A particular topic regarding the presumed clonal expansion of the type II strain of *T. gondii* is somewhat unresolved due to the question of whether natural selection is driving the predominance of type II, or is type II more common because it is the most ancestral type. I believe this question is likely to surface in different pathogen systems, and a multi-faceted approach is likely required for resolution. One approach is dating the divergence times of related strains, and I intend to incorporate dating in my future research in pathogen systems.

I'm sure that was very important for my future research, thanks have this workshop is possible working in a new model for *Toxoplasma Gondii*.

Thanks to the exhibition could better understand the cycle *T. gondii*.

This would depend on finding possible funding to develop a further collaboration at the international scale;

**Did you develop unanticipated plans for collaborative research with other Workshop participants?
Please explain: (n=12)**

CHANGING OF PGD STUDENTS TO OTHER LABS TO DO PART OF THEIR WORKS. WORKS RELATED WITH MY AREA OF RESEARCH.

I am a biologist and I did discuss potential new collaborative research with other biologists. However, I felt we just scratched the surface in exploring mathematical and modeling applications, and weren't able in the time available to identify research problems that may be amenable to modeling solutions. I'm a grad student, so any collabs would have to go through my PI.

My favorite part of the workshop was talking individually with so many interesting researchers. The input on my project and hearing people discuss their ongoing research inspired me to think in new directions and will directly shape some of my analyses and publications. I don't think I would have had the opportunity to communicate in such depth with these researchers at a large conference venue.

My joint work on within-host between host interactions was enriched and we got new ideas. We are writing a paper on that already

The workshop brought ideas that may become collaborative research. I am not sure whether NIMBioS is supposed to encourage further collaboration after the workshop?

I have communicated just this week with Lina Ocampo and John Baroch. (Also with Chunlei Su and Asis Khan, but this WAS anticipated). I am hopeful that other collaborations may ensue.

There may be a collaboration on parasite egress or perhaps modeling tachyzoite to cyst formation in the brain.

Mostly, I found some people willing to share techniques, etc, to assist both of us. It was a very nice setting for this!

A gentleman, Dr. Michael Gilchrist, gave useful explanations into modeling the Borrelia system. I asked if he would be willing to provide future assistance and he agree. I intend to contact him within one or two months.

Work to measure local area biochemistry around a tissue cyst in a mouse brain will be completed by laser micro-dissection and transcriptional profiling--in conjunction with Yasihuro Suzuki. Dr Michel Langlais and Dr Zhao offered to help me work out models for data that I had.

Did you develop unanticipated plans for collaborative research with other Workshop participants? Yes, in this moment with: Haema Casala from Texas Tech, UIC, NH Jorge X. Velasco Herandez from UAM Benjamin Rosenthal from USDA Lina Ocampo fom Quindo Univ Diego Aranda from Dristrict health secretariat Bogotá. we are working in a possible model for the Toxoplasma Gondii at microbiologic level. Yi Mao has this possible model.

In Nimbi stay, we formulated a mathematical model which we solve.

mixing intra-host and inter-host dynamics is a challenging idea.

Not yet

What do you feel was the most useful aspect of the Workshop? (n=24)

The hi-functioning, high energy breakout sessions were the most useful aspect of the workshops. Since they were punctuated by the talk, it was easy to pick up where the researchers left off., These sessions had a think-tank like feel to them. I learned a great deal during these sessions.

All of the dialogue between so many people with so many different backgrounds; really fantastic! You put mathematicians and biologists together and let them communicate and discuss the same topics. From all discussions, we know what others need and what we can do to understand the topics better. It is a good experience.

Expert talks combined with useful discussions across disciplines.

Long form talks with plenty of opportunity for Q&A; an intimate setting where everyone heard each talk.

The program was not jam-packed with presentations, and allowed lots of time between presentations and group discussions, for informal interactions and discussions. This format is tremendously valuable and in contrast to many meetings these days. The give-and-take allowed during the presentations was also a positive.

The workshop served as a good review of the biology of Toxoplasma from epidemiological aspects, to the immune response and dynamics of intracellular infection to cell and molecular aspects of the host/parasite infection. Considering this large overview of Toxoplasma biology from a mathematical/modeling view was informative and caused me to think about some of my studies from a different perspective and with different questions in mind.

The basic overview of each aspect of the parasite.

Having all biological and epidemiological information together within two days of the workshop was helpful and useful.

The last discussion on Saturday morning; you began to feel that the biologists began to understand and appreciate what modeling could do for them. It was somewhat exciting to see.

Many points were useful! The most useful was to discuss on which questions about Toxo were presently amenable to modeling or not (during the final discussion).

expand my horizon and learn more information

The learning of key details of the T. gondii system, and the transferable elements useful for the study of other pathogen systems.

Learn about the biology of the parasite

The most useful was the wide array of T. gondii research topics introduced and discussed.

Multidisciplinary team work

It was a great mix of biology and mathematics

EXCHANGES WITH mathematician and biologists.

The diversity of participants, the time allowed for discussion and the relaxed setting in which individual conversations were possible and encouraged.

the discussions period and getting an overall global view of toxoplasmosis.

Probably the small group discussions and generally the smaller and more focused the better - in my experience a small group discussion with 5-6 after the meeting before people left.

THE GREAT POSSIBILITY OF A SMALL GROUP OF RESEARCHERS TALKING ABOUT T. GONDII IN THE WIDE RANGE OF ASPECTS AND THE POSSIBILITY OF ASKING QUESTIONS AT ANY TIME DURING THE MEETING., I ALSO FOUND VERY IMPORTANT THE DISCUSSION IN THE SMALL GROUPS.

The talks.

The presentations

Got knowledge

I think the most important aspect is the contribution from each of the areas of work can provide. Furthermore, knowing the work that has been made over the years on *T. gondii*.

talking to reliable colleagues concerning available scientific knowledge and data to build better suited models?

The talks that clarified the biological cycle of *Toxoplasma gondii* and thus we were able to raise the new model

try to find some common language between mathematical model and biology

We had the opportunity to bring together biologists with different focuses and build up a big picture on *Toxoplasma*.

What would you change about the Workshop? (n=17)

It would be helpful to have a few more presentation to demonstrate actual examples of combining biological and mathematical approaches to analyze the mechanisms of biological phenomena. The discussion groups should have a designated moderator whose job is to keep ideas on track without suppressing valuable input from the participants, nor making participants feel excluded. This would be a delicate task.

The discussion groups, at times very chaotic.

Include more sessions. Create a follow up session/work shop.

I would allow the modelers to share more background on their approaches to encourage more dialogue with the biologists. I would build in more time for the breakout sessions and consider reducing the subject content of the workshop (even though *Toxoplasma* seems specific) as in modeling terms within host vs. between host modeling are quite different approaches.

The organizers did a good job of explaining the purpose of this meeting during the course of the workshop, But more clarity of the scope and purpose of the meeting beforehand would have been useful.

It would have been nice to have more group discussion time.

More structure in the breakout sections, with some mechanism to enforce 'mixing' among disciplines; perhaps more assertive facilitation of such sessions.

Again, more general talks on math modeling. The only talks that we had were very specific models, which was useful and interesting, but I would have appreciated a more general introduction to math modeling and how it is used in other systems, etc.

1. Bring more on modeling to biologist. Maybe try to really make them go into the modeling process, by proposing a small training where they would build a analyze a small model. I could have proposed such training, and probably for other workshops some modelers may do it for other subjects. 2. encourage discussions earlier in the process, so that participants may even go further in the modeling process before the end of the session: write a first model or begin the write the constraints to do it. Present more mathematical results and more mathematical models.

1. A brief tutorial on things mathematical models are useful for, how they can expand the usefulness of biological data and the types of data required would be helpful either before the meeting or at the beginning.

More time for discussions: 1. What needs to be modeled and why? 2. More interaction across disciplines to better understand what mathematicians needs e. g. type of observations and relative quantities.

shorter talks (some were 1.5h which is not acceptable)

Smaller discussion groups.

A better control of the time allocated to speakers

See my earlier comments. I think the topic was almost too broad and complex to do justice to in the three days. However, as a catalyst for the formation of working groups with a narrower focus, it may have been just about right.

Add a few lectures on the applications of mathematic modeling in biology. This will help biologists understand modeling even better.

It is important to know more about the work of all participants.

More group interaction will help a lot to develop some model

Nothing

The way to organize workshop.

this is just fine.

The Workshop format would be more effective if: (n=1)

Smaller discussion groups were organized.

More purpose directed.

Please indicate any changes NIMBioS can make to improve the resources and/or accommodations available to Workshop participants: (n=9)

Better coffee

Well....more fruit and less pastries, probably! Wouldn't have mentioned it, but you asked!

The Holiday Inn was a very bad choice for me: they put me in a smoking room that smelled as it should and also there was a dog show of some sort in town of which I have several participants barking until late night in my floor.....No availability of rooms to make changes.

In all honesty, I wasn't expecting or needing my own room. If finances are ever a concern, I think most grad students would be happy to room with other students.

If budgeting constraints allow for NIMBioS t-shirts to be made available to the workshop participants that would be very nice!

No problems. We are there to work and collaborate and the conditions were certainly adequate for that.

Excellent options for food and lodging...thank you!!

Great job!

Maybe have a place with tables to eat on while discussing. From a French point of view this is a fruitful combination!

Not too much, very good place actually.

Nothing.

this is just fine.

Please indicate any suggestions you have for facilitating communication among participants during the Workshop: (n=10)

Some people needed to give others more of a chance to talk during the discussions and question and answer sessions following talks.

The group was maybe a little too big?

Adding more break-out sessions

On this topic at least, smaller group discussion time would have been helpful to identify specific topics for working groups.

The smaller workgroups were useful and held the beginnings of productive exchanges between the mathematicians and the biologists. I think a little more time in these groups was needed even at this initial meeting.

a short poster session, with beverages/snacks, on one of the days will provide more results to look at, and a more concrete medium for further discussion.

Even smaller groups and more guidance of types of applications would be helpful. Maybe even before arriving a brief tutorial of the pathogen and some idea of the questions mathematicians would like to address.

ALWAYS THE PERSONS THAT DO NOT HAVE ENGLISH AS THEIR FIRST LANGUAGE HAVE SOME MORE DIFFICULTIES IN THE PARTICIPATION, HOWEVER IT IS NORMAL AND WHEN THE GROUP IS SMALL IT IS EASIER TO ASK QUESTIONS AND CHANGE IDEAS.

Might be a way to nudge students to participate more. Reserving a time for their questions, perhaps? Webinars for follow up sessions in addition to all this.

more group interaction will be needed

Personal mail, with the persons that want working in the mathematical model and your interest in working with him.

this is just fine.

Other social network tools used: (n=6)

email

I must be a dinosaur! I use e-mail incessantly, and that's all my brain can handle!

Telephone, email

Webinar and Web conference

Wiggio

YouTube, LinkedIn (professional social networking site) ---no to the next question, but yes after the conference

If you maintain a blog about your research and would like a link posted on the NIMBioS website, please provide the URL here, along with a brief description of the blog: (n=1)

I will ask permission from my research group and request a link later if applicable

Please use this space for additional comments: (n=6)

The workshop was a very positive experience for me and I truly appreciate that you encourage graduate students attending by providing vital travel support. I interacted with so many excellent researchers and will incorporate information from the group discussions as well as my personal interactions into my research plans. Thank you for this opportunity.

What about the follow-up of working groups after the workshop, it may be useful also.

Chunlei did a great job recruiting a good group of *T. gondii* researchers and mathematicians

I am grateful for this opportunity. I thank the organizers of this workshop for this opportunity to participate and learn so much.

Thank you so much for hosting!

Thanks for the workshop. It was very useful for me. Hope to continue my participation via a working group, if one takes shape along lines of my interests and expertise.