

## **CALTECH SCHOLARS EXCHANGE PROGRAM APPLICATION DIRECTIONS AND INFORMATION for Summer 2024**

**Pembroke College deadline date:  
16 October 2023**

**OVERVIEW:** Students from selected Cambridge Colleges (Corpus Christi, St. Catharine's, St. John's, and Pembroke) are hosted by the California Institute of Technology (Caltech) to perform ten weeks of supervised research on campus. In turn, Caltech students are hosted by these colleges and study for Michaelmas or Lent Term at Cambridge. All applicants must be 2<sup>nd</sup> or 3<sup>rd</sup> year students and not graduating in June. Third year students tend to have more coursework and research experience and are a better fit for this program.

**APPLICANTS:** **Students cannot apply outside of nomination by their college's senior tutor's office.** *Students not selected by their college cannot apply independently for summer research at Caltech.* Applicants should be at minimum in their second year of study. Applicants with previous research experience are preferred as are applicants with First Class examination results. Students lower than an Upper Second will not be considered. Applicants cannot be in their final year of their degree program.

**DATES:** All exchange students must work 10 continuous weeks. Applicants arrive between June 19 and 21. Students must arrive no later than noon at Los Angeles International airport (LAX) as check in to housing is not available on weekends and only available between 8:30am and 4pm on weekdays. All exchange participants must participate in a one-day exchange orientation to be scheduled by Fellowships Advising and Study Abroad (FASA.) ***No extension or abbreviation of the research period will be made for any reason.***

**LOCATION:** **The California Institute of Technology** is located just north of the City of Los Angeles at the foot of the San Gabriel Mountains and 10 miles northeast of downtown Los Angeles. Caltech: <http://www.caltech.edu>  
Pasadena, CA: [https://en.wikipedia.org/wiki/California\\_Institute\\_of\\_Technology](https://en.wikipedia.org/wiki/California_Institute_of_Technology)

**STIPEND and HOUSING/MEAL CHARGES:** Those selected for the exchange will receive a stipend ~ \$7200 to \$7300 for the 10 weeks of the exchange with the amount set by next April. The exchange is a research experience for students. Students will be able to cover living expenses and some entertainment and local/weekend travel from their stipend. But this is not a summer experience that has the high salary students could find in industry.

Note that ~ \$5000 to \$5500 is needed to cover rent, living, and food expenses for

the summer. The room rate for the 10 weeks for the summer of 2023 was \$1,295.00/month for ten weeks. Students were also charged \$530 for the mandatory board plan. These funds can be spent on meal charges at cafeterias, cafes, and convenience stores on campus. The expenses for meals for the ten weeks at Caltech will vary considerably as to whether a student primarily cooks their own meals, eats meals in campus cafeterias or cafés, orders delivery or takeaway, or eats in restaurants. We suggest budgeting about \$1000 to \$1500 for meals in addition to the mandatory board charge. Note that the housing and board fees will likely rise 3% to 5%. These rates are not set by the housing office until the spring term.

Students will live in halls of residence on the Caltech campus that have air-conditioning, wireless, modern bathrooms & kitchen. Students will live in a single room on a hallway or suite. Students may not arrange their own housing.

Usually, students are allowed to pay for room and board charges the week their first paycheck is received at the start of July. Students pay for their own airfare and related travel expenses. Students selected for the Caltech Scholars Program can ask their own college about travel funding through the college. All housing is arranged by Caltech and is on the campus in modern, air-conditioned single rooms on a hallway or in a suite in a Caltech residence hall. There are shared bathrooms and kitchens on each hallway or in each suite. Students are charged the same room rate as regular degree candidate Caltech undergraduates and not the higher visitor rate, a benefit of the exchange. Students will need to sign the housing contract and agree to its terms.

The stipend is taxed based on the student tax treaty of the country of their citizenship has with the U.S. Some taxes can be reclaimed from the U.S. taxation office, IRS (Internal Revenue Service) after the tax year ends. There is information online at the IRS website and Caltech usually provides software to help international students file their taxes in the early spring of the year. Taxes can only be refunded after the calendar year has ended and the student has received a wage statement from Caltech known as the W-4 form, which will be a statement of your wages and tax deductions at Caltech. Aside from the software provided, we cannot provide any tax advice. The Caltech payroll office will adjust your tax deductions based on your country of citizenship.

**APPLYING:** All applicants should submit essays, a faculty list, and other required documents in a Word format and NOT a PDF format to their college, except for their college transcript, senior tutor nomination letter and two signed letters of reference. Please put your name, College, year of study at Cambridge, tripos and subject within the tripos and part, e.g., Natural Science (Physics Part II or Engineering with focus on Electrical, Part IIA. Do not simply state Natural Sciences, or Engineering as you need in these fields with track/disciplines to specify what you will have as your major subject.

***Applicants should submit the following to their designated college official by the college deadline specified on the first page of this document.***

**Please provide the following materials AND SUBMIT IN WORD FORMAT NOT PDF OR LATEX, or other FORMAT.**

•Label the document itself with your name and type of document, e.g., Leslie Wang Research Essay

***Please put your name at the top right of each page, your college, your major subject at Cambridge and your year of study/tripos part. Insert page numbers on each page. Label each document with your name college and type of document.***

For example, on each page of each essay except your CV and put your name and college on each doc, e.g., Peter Chang, Name of College, Faculty list or CV, etc.

Name each document except the CV, which can retain whatever format you have it in:

Your Name

Your College

Your Tripos and major subject within the Natural Science or Engineering your area of specialization and list the Tripos part you will be currently in.

What the doc is, e.g., Research Essay

***SUBMIT THE DOCUMENTS BELOW TO YOUR COLLEGE in the format specified above.***

1. A short essay (one-page single spaced maximum) on why you would like to undertake this summer of research at Caltech and how the experience would complement your academic & professional plans and goals. Physics Part II or Engineering IIA students applying for one of the two LIGO research positions must write a second essay.

2. A statement of research interests and previous research experience.

It is helpful for the applicant to note familiarity with programs such as Matlab or other computer programs or languages that might be related to their area of research interest or experience with relevant experimental techniques or equipment. However, such prior experience is not essential. Students will learn whatever is needed to for the research project and Caltech will provide exchange students software relevant to their research.

(Provide statement in Word format)

3. CV (Word format preferred) Include both your Cambridge email and an alternate email such as Gmail.

4. A list of 8 to 12 Caltech faculty with whom you would like to conduct research.

APPLICANTS SHOULD NOT PROPOSE A PROJECT OF THEIR OWN DESIGN. (The student does not devise the project. For students selected to the

exchange program a project will be devised or assigned by the supervising faculty member with input from the student.)

Rather, the applicant should describe what projects or areas of research SPECIFIC to each proposed faculty member's current research in which the student would like to conduct research.

Be very specific as to how your experience has prepared you for this research group. What classes, skills (Matlab, experience with equipment, previous research including any done in a gap year, term, or summer) that demonstrates your preparedness to enter each group. Note well that research is not a class. You need to have a good base of information and experience to be able to successfully engage in each group's research.

Applicants should read about each faculty's research area and group on the Caltech web page. Be certain to list current research and not research completed and published and not currently ongoing. (Word Format)

Applicants should only list professorial faculty, not postdoctoral students, or non-professorial faculty, unless the student also lists the professorial faculty member who supervises the postdoctoral or non-professorial faculty. There are no assignments available at the Jet Propulsion Lab (JPL).

Students should go to <https://divisions.caltech.edu> and choose a division (faculty) or interdisciplinary programs and then choose research. This will take applicants to a list of professors or assistant professors and their areas of research. Note that we do not have a medical school and medics need to be prepared to work in the Biological Sciences and Bioengineering Division BBE.

Also note that physicists, chemists, or biologists can review the faculty in the Division of Geology and Planetary Sciences. Here you will find fields such as geobiology, geochemistry, geophysics, and planetary sciences.

Mathematicians will not be placed in the mathematics department as faculty rarely take visitors. Look at the Engineering and Applied Sciences Division for the fields of engineering, computer science and applied mathematics.

5. A transcript showing exam scores and the applicant's coursework, i.e., a list of classes taken and being taken. (PDF format)

6. A letter of nomination from the college that states why the applicant was selected for the exchange. This should be sent as a PDF with signature or by using the attached reference form that has an electronic signature box.

7. Two letters of recommendation from faculty in the student's subject or highly related area. These should be sent as a PDF with signature or by using the

attached reference form that has an electronic signature box.

### **Research area caveats:**

We are normally not able to place students in pure mathematics or any theory area unless a student has a contact at Caltech who has agreed in writing to supervise that student. However, it is possible to place students studying pure mathematics in non-theory areas in fields such as physics, applied maths, engineering, geosciences, etc.

### **Creating a list of possible faculty supervisors:**

Note that the project the student does over the summer will be developed with the approval of the faculty member who agrees to supervise the student. If your college requires applicants to submit a sample project, it is **not** possible to carry out these projects. Colleges have been asked not to require this. The supervising faculty member will determine the research project usually in consultation with the student and any graduate student, postdoctoral scholar, of staff scientist who is named as the co-supervisor.

Projects cannot be independent research in which the student is trying to carry out an idea of his or her own using the facilities of Caltech. Students will be assigned to a research project for which they will develop a proposal and they will have input. *Students need to be flexible about the final project and that the purpose of the exchange is to work under the supervision of someone with mature intellectual judgment and research experience.*

Applicants should understand that **published research may not be related to ongoing work.** Students should review the work of graduate students or postdoctoral scholars to gain an idea of the work in the group. However, graduate students and postdoctoral scholars are not permanent members of a research group and may not be at Caltech during the summer a Cambridge student is at Caltech. A postdoctoral scholar may have completed their research appointment by June and a graduate student may be receiving their PhD in June. Note well: Only a professorial faculty member can agree to have a student in their group. Faculty associates or other non-professorial faculty are soft money faculty and not on the professorial track. The range of their authority to accept students will depend on their appointment type at Caltech. Caltech faculty will have the title of professor or assistant professor.

### **IMPORTANT ASPECTS OF THE EXCHANGE TO NOTE**

Students may not work for fewer weeks than TEN regardless of their start date or other plans for the summer. The official start of the program is mid-June. Students with major commitments for the May Ball week may not be good candidates for the exchange as no exceptions are made to the start date!

Students should note that the first week of July contains the American holiday of celebrating independence from England, July 4<sup>th</sup>- Independence Day and Caltech will be closed on that day and if July 4<sup>th</sup> falls on a weekend for the Friday before and Monday after.

**Housing is available through the end of August. No extension or abbreviation of the research period will be made for any reason.**

Students can travel at the weekend. Students have time to travel in the U.S. based on their end date during late August and September as the student visa allows a grace period after the end of their ten-week research commitment. Exchange participants must return to Cambridge for the start of Michaelmas Term.

Student's Name:

Tripes/Subject:

Year of Study:

College:

### **Research Interests**

I have really enjoyed the challenging course material in my both my first and second years at Cambridge, and now look to supplement this material by undertaking an exciting research opportunity at Caltech.

I particularly enjoyed the quantum mechanics and solid state courses last year, and the optics that I have studied over the last two years. My enjoyment of these topics has been the overriding factor in my decision to pursue the research areas of photonics, optics, and nanotechnology. I recently began my experimental project that is related to optics, in the area of illuminance fluctuation spectroscopy. I am also fascinated by the applications that these branches of physics have, as they are vital to our current lives and will certainly lead to technological advances in the future.

I also keenly follow nuclear physics and particle physics, through further reading, and I'm really looking forward to my particle physics course next term. My interest in the area was sparked when I completed a report based on the subject of using Thorium as a nuclear fuel. I have also expressed interest in two areas related to astrophysics, because of a strong interest in the subject.

I would prefer to undertake an experimental placement at Caltech. This is mainly because I will be completing experimental projects as part of my part II course, and I think my future in physics lies much more in experimentation.

### **Previous Research Experience**

My main motivation in applying to Caltech is to undertake significant research work that I have not had the opportunity to undertake at present. A placement at this world-renowned institution would be invaluable to me, and I would gain invaluable laboratory experience and a significant number of new experimental skills.

Over my first two years at university, I have undertaken the part I laboratory programme and I am currently taking part II experimental work. I completed an introductory course in C++ programming, and its application in physics based situations. I have enjoyed this aspect of my course, and will continue to improve my skills through personal projects. I also have familiarity with Matlab and Mathematica through previous courses and am always enthusiastic about learning any new languages.

**Student's Name**

Tripes/Subject:

Current Year of Study:

College:

**Research and Coursework Background Statement**

**Research Experience**

*Kimata Lab, Department of Genetics, Cambridge. (Cell Cycle and Cancer, Cancer Research UK)*

During this internship (Summer 2022), I worked on characterising proteins at the centrosomes that are targets of APC/C, employing techniques such as PCR, Transfection, RNA interference, Cell Culturing, fluoro-microscopy, slide preparation, and Western Blotting. I helped to design and perform experiments with other members of the lab. Additionally, I worked on the role of Vihar in chromosomal instability and examined the role of Fzr in centrosome clustering in D.mel2 cells. In December 2022, I was recalled by the lab to investigate the effect of Vihar on nucleus size. I employed fluorescent microscopy and also used the NIS Visual Elements programme to aid with image capture and analysis.

*Molecular Biology Lab, Sindh Institute of Urology and Transplantation, Pakistan:*

The techniques I learned here were similar to the ones already mentioned before. moreover, I learned how to perform DNA sequencing and extraction and observed DNA and tissue typing.

**Coursework**

As part of the MVS Tripes (Medicine) I took Biochemistry, Human Anatomy, Histology and Physiology as my first year courses and have Neurobiology, Pharmacology, Head and Neck Anatomy, Human Reproduction, Neuroanatomy and Pathology as my second year courses. These courses are a year-long and are accompanied by practicals. The Anatomy courses involve extensive dissection alongside applied sessions and Histology involved slide preparation and microscope based observation. Other practicals conducted are listed by subject.

*Biochemistry:* Colourimetric Assay, Gel Electrophoresis and ELISA to asses proteins that are markers for disease. Experimentation on mitochondria using oxygen electrodes to investigate metabolism. PCR and Plasmid Splicing. Bioinformatics exercises.

*Physiology:* Electrophysiological experiments, involving frog muscle and nerve. Experiments involving electrocardiograms, blood pressure and exercise physiology. Respiratory physiology investigations primarily involving spirometers.

*Pharmacology:* Radioligand binding experiments. Langendorff isolated perfused heart preparation. Drug-receptor interactions. Trace analysis. Pharmacokinetics investigations.

*Pathology:* Examination of histopathological conditions. Agglutination and Precipitation assays (Antibodies). Complement fixation tests. Assays for viral identification and titration. Experiments involving bacteria and cancerous tissue to follow.

*NeuroPhysiology:* Investigations into the structure and function of the eye, the psychophysics of audition. Experiments involving ischaemic nerve block, electrophysiology and eye movements.

In addition to this, my A-2 level courses (year 13 courses: equivalent to many of the first year courses offered at US universities) included Biology, Chemistry, Physics and Mathematics. The three sciences had extensive accompanying practicals.

These practicals have allowed me to gain experience in applying some experimental techniques to problems set, while considering carefully the controls involved to make the experiments successful. The diversity of techniques allows me to use a multidisciplinary approach to experiments.



**Student's Name:**

**Major Subject at Cambridge: Natural Sciences (Biological) Year 2**

**Note well: This student has done a fairly good job of relating their previous experience to each research group. The more specific the better! List course names and specific techniques or programming skills related to each research group.**

**List of Caltech Professors with whom I would like to work – In order of alignment to my research interests (most passionate first)**

**1. Bruce A. Hay**

The work of the Hay lab perfectly aligns with my research interests and motivations to work in science. Transgenic mosquito gene drives to prevent mosquito-borne disease transmission is the research branch that I am passionate about, as genetic systems for vector-mediated malaria prevention were the subject of the literature research project which inspired me to study pathology at Cambridge. Moreover, this area is ideally complemented by my interest in evolutionary theories and population dynamics, which must be considered when applying these innovations in the field. My previous research experience at the NHS Blood Component Development lab had direct industry link to develop technologies to improve human lives, and so I am similarly drawn to this high impact research, especially due to its potential applications for people of underdeveloped nations – the key motivator for why I want to pursue a career in research. I am keen to build on my experience of developing biological products, analysis machines (including the Sysmex and flow cytometer) and meticulous data handling, as well as gain experience in genetic techniques in *Drosophila* as a model organism.

I am also interested in the one-shot contraception technology research branch, as this also aligns with my values of creating interventions to dramatically improve the lives of those in health infrastructure-poor settings, combined with the appeal to my interest in genetic engineering technology.

The Hay lab research area is the I could see myself joining in the future, making this the ideal placement to boost my research journey in this direction.

**2. Pamela Björkman**

Investigating the immune response against SARS-CoV-2 is of major interest to me. I have keenly followed the research developments surrounding the pathology of the exaggerated immune response associated with Covid 19, as well as the mechanisms underlying the varied susceptibilities. This branch of the Björkman lab appeals greatly to my pathology interests as well as personal motivations to improve human lives through research. This builds upon my experience researching at the NHS Blood Component Development lab where likewise health-orientated research had direct impacts on therapeutic protocols, and where I developed skills in the use of complex analysis machines such as the blood coagulometer, Sysmex and flow cytometer. Having learnt about them through their impact on cellular microbiology understanding, I now want to develop my experience in structural biology analysis such as through X-ray crystallography and electron microscopy techniques. A placement at this lab would develop my passion and experience in pathology research in an area which has been of keen fascination for the past 2 years.

**3. David Prober**

Having volunteered for the past 3 years to provide one-to-one support to a girl with autism and carer relief to her family, the Prober lab autism research branch combining my keen concern and interest in autism with fascinating biological techniques would be an ideal placement. I am interested to combine techniques I have learnt about in my Cell and Developmental biology such as mutant screens and sequencing, with my model organism handling experience developed in practicals investigating grouping preferences in stickleback fish in Evolution and Animal Diversity practicals. I would like to build on model organism experience through working with Zebrafish, especially in the assessment of more complex phenotypes such as social interaction. I am also keen to perform mutant screens in a more derived eukaryotic organism and expand my understanding of genetic techniques.

**4. Sarkis Mazmanian**

My passion for evolution has led me to investigate the symbiotic relationships of inter-kingdom signalling, including microbe-gut epithelial cell interactions – such as epigenetics-mediated alteration of gene expression in gut epithelial cells, and its association with microbiome-associated diseases. The causative links between expression patterns and individual microbiota fascinated me and so I am very interested in the gastrointestinal research branch of Mazmanian lab. I am particularly interested in its implications for understanding the environmental influence of autism – both due to curiosity in the evolutionary ‘nature-nurture’ interaction involved, but also on a personal level, having significant experience in caring for children with autism.

**5. Magdalena Zernicka- Goetz**

My motivation for research is driven by its potential impacts for improving human lives through therapeutic development, meaning that many of the Zernicka-Goetz research branches align closely with my interests. I am keenly interested in the evolution of interkingdom mutualistic relationships between the gut and commensal microflora. Therefore, the interaction between the human microbiome and the neuroinflammation of Parkinson’s disease combines my evolution interest with a strong orientation to pathology research. In addition, embryonic development is a topic I found fascinating in Biology of Cells lectures and am pursuing further this year in Cell and Developmental biology. The potential applications of maternal factor assessment to develop a non-invasive method to predict embryo transplant success to improve IVF treatment also closely aligns with my research motivations.

**6. Viviana Gradinaru**

Optogenetics is a fascinating technique which I would be keenly interested in gaining experience in, especially as such a defining biotechnological development revolutionising neuronal research. Using light to inhibit neuronal firing to understand altered neurone firing in disease states appeals to my desire to enter pathology research to improve understanding and eventually patient outcomes. I am also keenly interested in the targeted gene transfer technology of recombinant adeno-associated viruses and am keen to develop experience in this technique due to its wide-ranging impacts for in-vivo complex tissue, including neuronal, repair.

**7. Ellen Rothenberg**

Understanding the molecular mechanisms which control T-cell lineage choice combines my interest in developmental biology and gene expression control (such as transcription factors and epigenetics), with immunology. I am keen to gain experience culturing stem cells, experimentally manipulating their transcription factor expression, and interpreting the data through multigene

correlation analysis. Having gained experience in flow cytometry whilst working at the NHS blood Component Development Laboratory, I am keen to develop this skill from quality control and sample running to more specialised Fluorescence Assisted Cell Sorting within the interesting context of tracking T cell development. Whilst researching the lab I have enjoyed exploring the Bio Tapestry tool to visualise genetic systems and I would like to develop my understanding of this.

**8. Long Cai**

Having studied the progression of cellular microscopy techniques and their role in research acceleration in Cell and Developmental biology, the development of comprehensive mapping of molecular processes in tissues – involving RNA sequencing within a spatial context is a novel and exciting concept which I would be keen to be a part of. The images and associated understanding of sequential fluorescence in situ hybridisation are fascinating and I am very keen to build on my light and immunofluorescence microscopy experience through learning this technique it is a technology which is likely to permeate cell biology research.