IAP Webinar:
Building Trust in Science Through Science Education
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Innovative Approaches to Science Education: Portable Labs, Zebrafish, and Genomics in the Classroom

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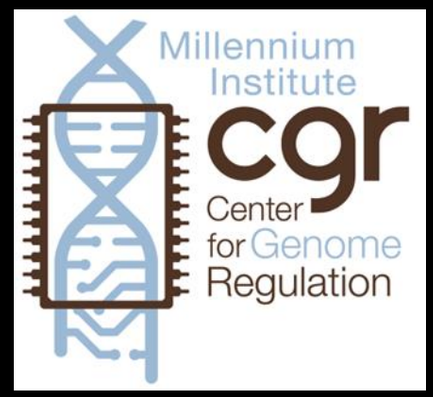


www.zebrafish.cl

www.institutocrg.cl

UNIVERSIDAD DE CHILE

FUNDACION Allende Connelly

Millennium Institute cgr Center for Genome Regulation

1000 Genomas
Chile Secuencia a Chile

ECBI (Inquiry Based Science Education)

Primary Education

Classroom sequencing initiative

Portable Labs Project

High School Education

Our programs for High School Education in Biology

- Portable Laboratory Program (2013-)
- High School Independent Projects (2015-)
- Genome Sequencing in Schools (2018-)

From: https://www.youtube.com/watch?v=ghhe2yuA8FM&t=1s

1. Portable labs program

- Topics or modules are selected at workshops between educators and university academics.

- Yearly calls for applications are made through various channels

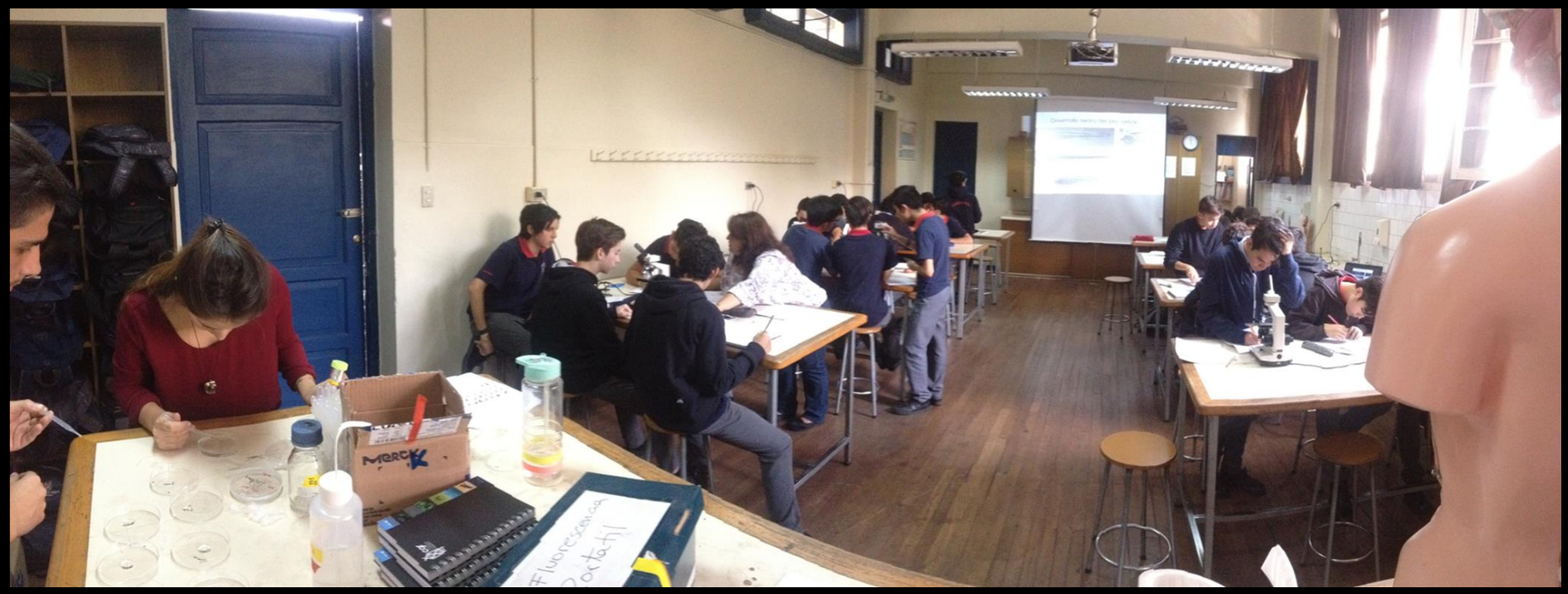
1. Portable labs program

- High school teachers are selected to participate in the one week-long training course.
- Once they have taken the training at the university facilities and passed the exit exams, they are offered the portable lab for their schools

1. Portable labs program

- The portable lab is taken to the schools accompanied by two instructors (PhD students)

- We survey teachers and students to evaluate the impact of the activity



Milestones of the portable labs program

2013: 1 portable lab module in Molecular Biology

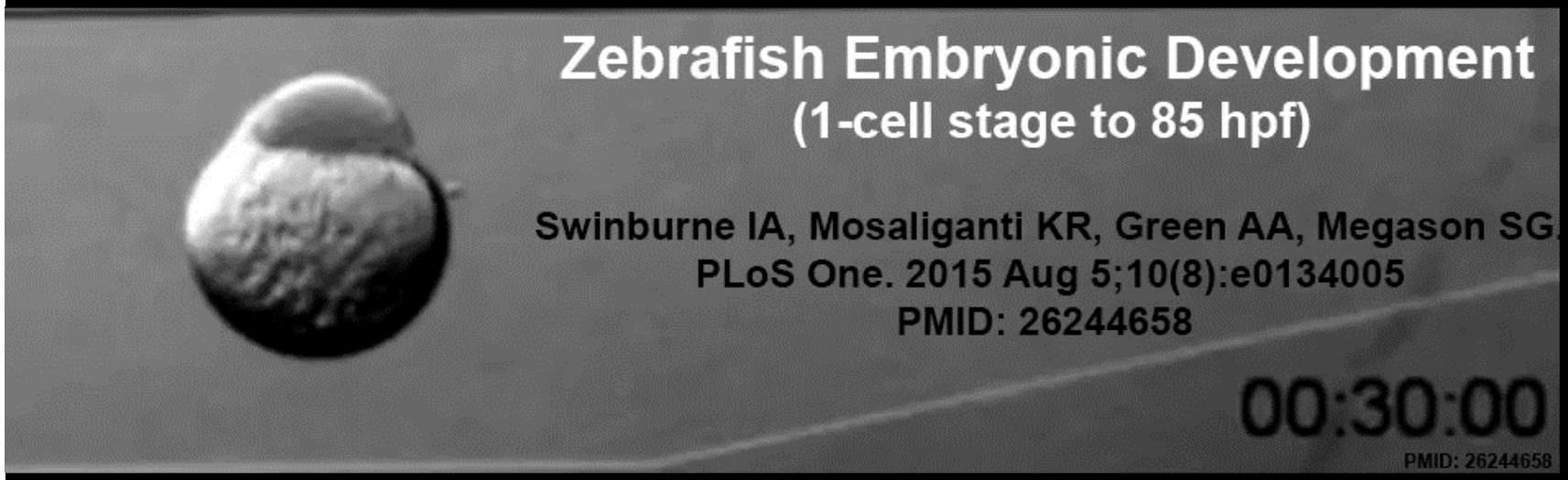
2018: 4 different portable labs (Molecular Biology, Enzymology, Microbiology, Developmental Biology), carried out in 50 high schools impacting 1200 students

2020: Program suspended due to the COVID Pandemic and Jorge Allende's retirement

2023: Reinitiated Dev Bio module and added the genomics module. Carried out in 25 schools over two years impacting over 800 students.

The program has been "exported" through the RELAB program throghout Latin America

The zebrafish as an educational tool



Transgenic fish

(Green fluorescence in vessels and heart , red fluorescence in blood cells)

Developmental effects of cigarette smoke

2. School student independent projects

- Between 2017 and 2019: 59 school projects
- Materials and experimental advice are provided from sponsoring universities
- Usual timeframe is one semester for completion of the project
- Results were presented in different venues such as science fairs and profesional scientific congresses

Examples of independent projects for the zebrafish module

1	Proseguimiento proyecto "Pez Cebra y el humo del cigarrillo"	Valentín Letelier
2	Uso del pez Cebra como modelo de estudio de los efectos nocivos de riles en seres vivos	Bicentenario Polivante San Nicolás
3	Efectos de las bebidas energéticas sobre el desarrollo de Danio Rerio	Colegio Padre Pedro Arrupe
4	Efectos que produce los suplementos alimenticios en el desarrollo del pez cebra	Colegio Padre Pedro Arrupe
5	Efectos de la toxicidad de plantas medicinales en pez cebra	Liceo Juan Agustín Morales
6	Efectos del uso de antibióticos en el desarrollo de peces cebra en su etapa embrionaria	Colegio San José
7	Uso de pez cebra para determinar la relación de la concentración de oxígenoen el medio con el crecimiento durante el desarrollo temprano	Colegio San José
8	Pez Cebra y efectos de la cafeína	Valentín Letelier
	REgeneracion y aloe vera	Colegio fco javier
9	efecto de la dureza del agua potable de la comuna de Huechuraba en el desarrollo embrionario de Danio rerio?	Colegio fco javier
10	Efecto de la cúrcuma sobre el desarrollo (proliferación) y regeneración del pez cebra.	Liceo 7 Bicentenario Teresa Prats
11	Efectos del BPA en el desarrollo embrionario del pez cebra.	Liceo 7
12	‘‘Efectos del humo de tabaco en el desarrollo embrionario y larvario	Instituto nacional
13	Efectos de los grados alcohólicos en el desarrollo embrionario y larvario de pez	Instituto nacional
14	Efectos de detergentes comunes y biodegradables en el pez cebra	Instituto nacional
15	¿Pueden los rayos UV afectar en el desarrollo embrionario de un pez cebra?	Liceo 1 Javiera Carrera
16	Efectos de las bebidas energéticas sobre el comportamiento y la anatomía del	Liceo 7

3. High school genome sequencing

- Arose from a network of scientific centers of excellence called the “Chilean 1000 Genomes Project”
- The Project, aimed at developing genomics and sequencing in the country, includes a strong component ef education and citizen science.

www.1000genomas.cl

3. High school genome sequencing

- It is a new portable lab module, with variations
- Between 2018-2024
- Nationwide applications to participate in the event
- 100 schools have applied; 30 have been selected

- It is made posible by portable and miniaturized genome sequencers from Oxford Nanopore (they have been sponsors in two of the events)
- A common organism (invertebrate) is selected and students are asked to collect simples near their school. Recently, we have also added metagenomes from soil samples
- Because of bioethical considerations, simples are processed at the university, but DNA extraction is carried out at the schools
- The CGR team visit the schools and spend three days with the class doing the library preparation, sequencing and bioinformatic análisis
- “Dead” times are used for theoretical excercises and games oriented towards understanding genomics, genetics, Genome assembly and annotation and its significance for human health and biodiversity knowledge

Figure 1: Pictures with some activities performed by students on each school:

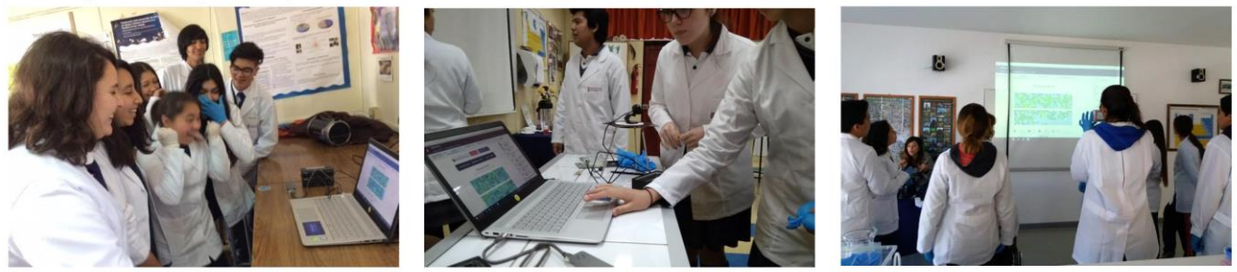
- Sampling on site

- A brief presentation about sampling and what student prepare about common pill bug

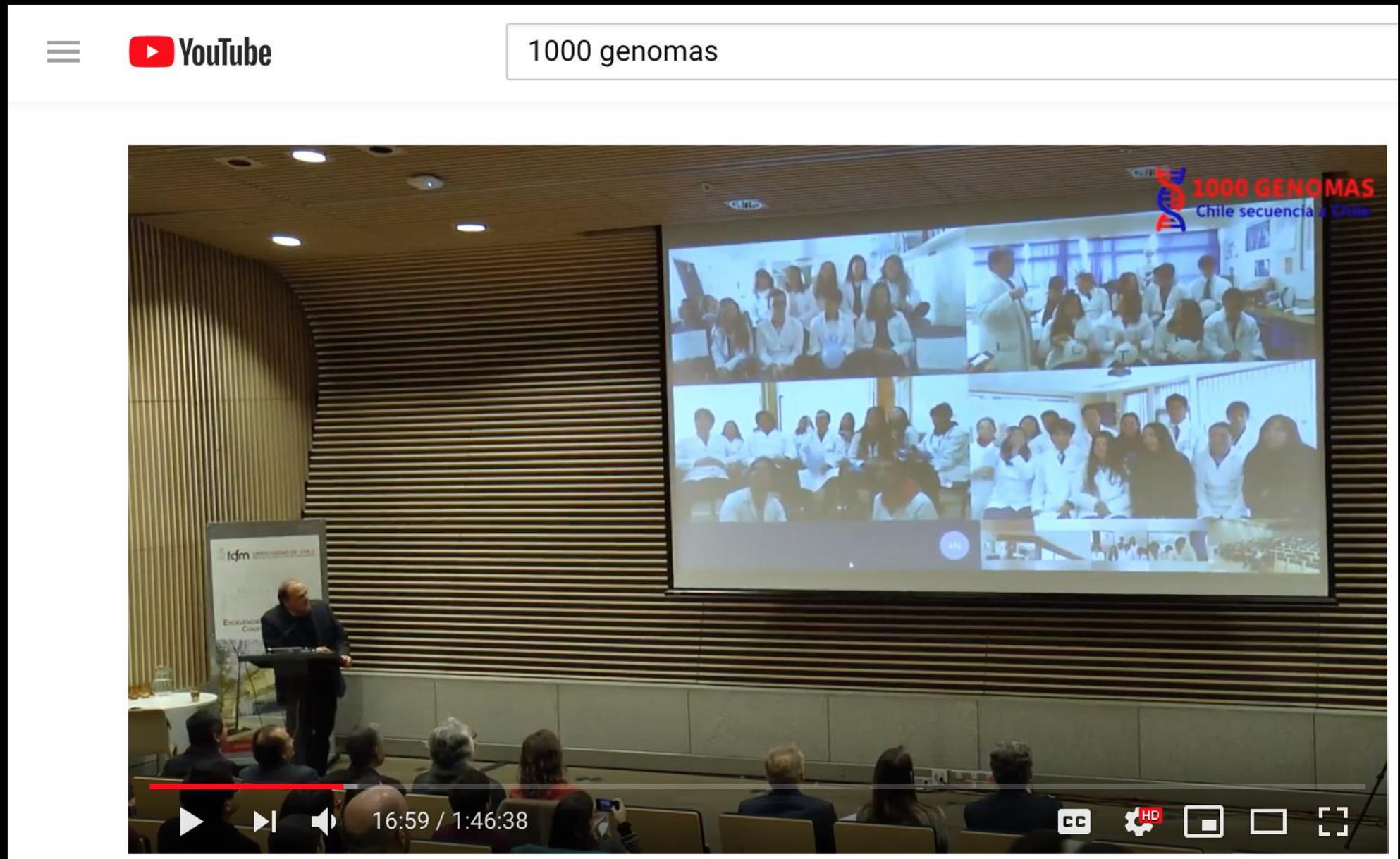
- Exercises on molecular biology concepts (play time)

- Some lab work and nanopore cell setup

- Nanopore ssequencing for about 6 to 24 hrs. ☺



Evento de lanzamiento



Canal 1000 genomas: https://www.youtube.com/channel/UCWvLjdI4G70f1DZsVIDDlIQ

- We share the results with the students and present them at national scientific congresses.

- For the 2019 event, results were novel and of high quality, enabling us to publish the results

***De novo* genome sequencing by secondary school students in the classroom: a collaborative experience with Oxford Nanopore technology**

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Biological Research

RESEARCH ARTICLE Open Access

DNA sequencing in the classroom: complete genome sequence of two earwig (Dermaptera; Insecta) species

Sanae Kobayashi[1,2†], Jonathan E. Maldonado[1,3†], Alexis Gaete[1,4], Ingrid Araya[1,5], Constanza Aguado-Norese[1,4], Nicolás Cumplido[1,2], Sebastián Díaz[1,2], Alonso Espinoza[1,6], Edelmira Fernández[1,2], Felipe Gajardo[1,2], Felipe González-Ordenes[1,2], Khantati Hauyon[1,4], Piedad Maldonado[1,2], Rodrigo Maldonado[1,7], Isabel Pochet[1,11], Aníbal Riveros[1,9], Paula Sandoval[1,10], Ailynne Sepúlveda-González[1,4], Camila Stuardo[1,4], Patricio Tapia-Reyes[1,11], Carolina Thornton[1,11], Soledad Undurraga[1,12], Macarena Varas[1,2], Camilo Valdivieso[1,2], School Earwig Genome Consortium, Rodrigo A. Gutiérrez[1,11], Ariel Orellana[1,6], Martín Montecino[1,7], Alejandro Maass[1,13], Mauricio González[1,4], Miguel L. Allende[1,2], Christian Hodar[1,4*] and Paula Irles[8*]

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HIghlights of surveys among teachers and students

- The most attractive feature for any activity in biology is to be able to work with living systems
- It is important to be able to see results in real time with their own eyes.
- There is a high level of concern about our impact on ecosystems and the environment. A link between the activities carried out and global issues is a plus
- Critical to have the support and infrastructure of the universities as schools do not have access to these facilities or expertise
- Teachers feel empowered but also are concerned that they may be part of an elite

Issues that should concern us as scientists and educators

- The world is undergoing physical changes simultaneously with geopolitical, economic and social transformations

- Threats to a free and open society are, among others: denial of truth and facts (climate change, vaccines, GMOs, etc), fake news, conspiracy theories, misuse of AI, religious dogma in the classroom.

- In society, there is a lack of critical thinking skills, discerning between reliable and poor reference sources, skeptical outlooks on “established fact”

Where to focus efforts in the midst of this crisis?

- While teaching scientific skills is important and necessary, a broader form of scientific literacy must also be incorporated into our initiatives.
- We cannot miss the opportunity to teach the scientific method, how to conduct proper reference sourcing or fact checking, to show that truth and knowledge are attained little by little, often by trial and error.