AFRICAN CENTERS OF EXCELLENCE IN BIOINFORMATICS
BAMAKO, MALI

ACE | AFRICAN CENTERS OF EXCELLENCE IN BIOINFORMATICS

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HEALTH INNOVATION CONFERENCE UGANDA MARCH 20, 2019

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Needs and Driving Factors

- **Fact**: Research opportunities abound in Africa, especially for infectious diseases

- **Fact**: High-throughput sequencing and other 'omic approaches have revolutionized biomedical research

- **Problem**: Researchers in Africa cannot take advantage of these new techniques due to lack of access to training, infrastructure, and long-term support
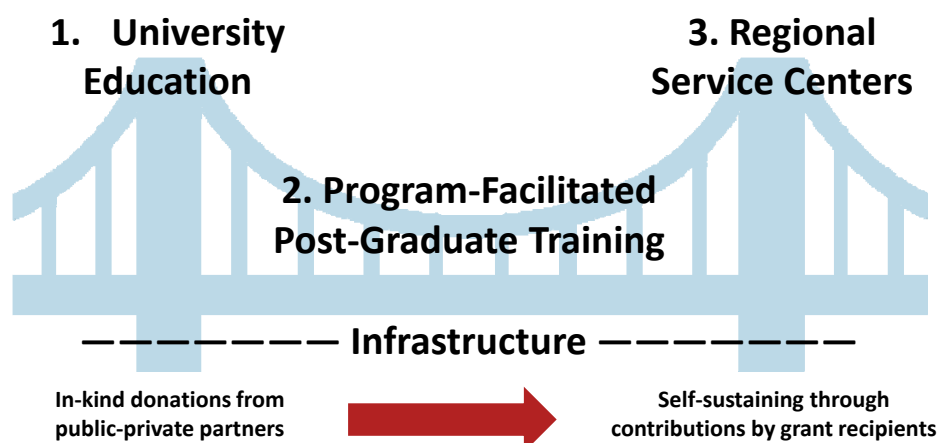
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The vision of the ACE Program is to

build sustainable capacity
for bioinformatics
in sub-Saharan Africa

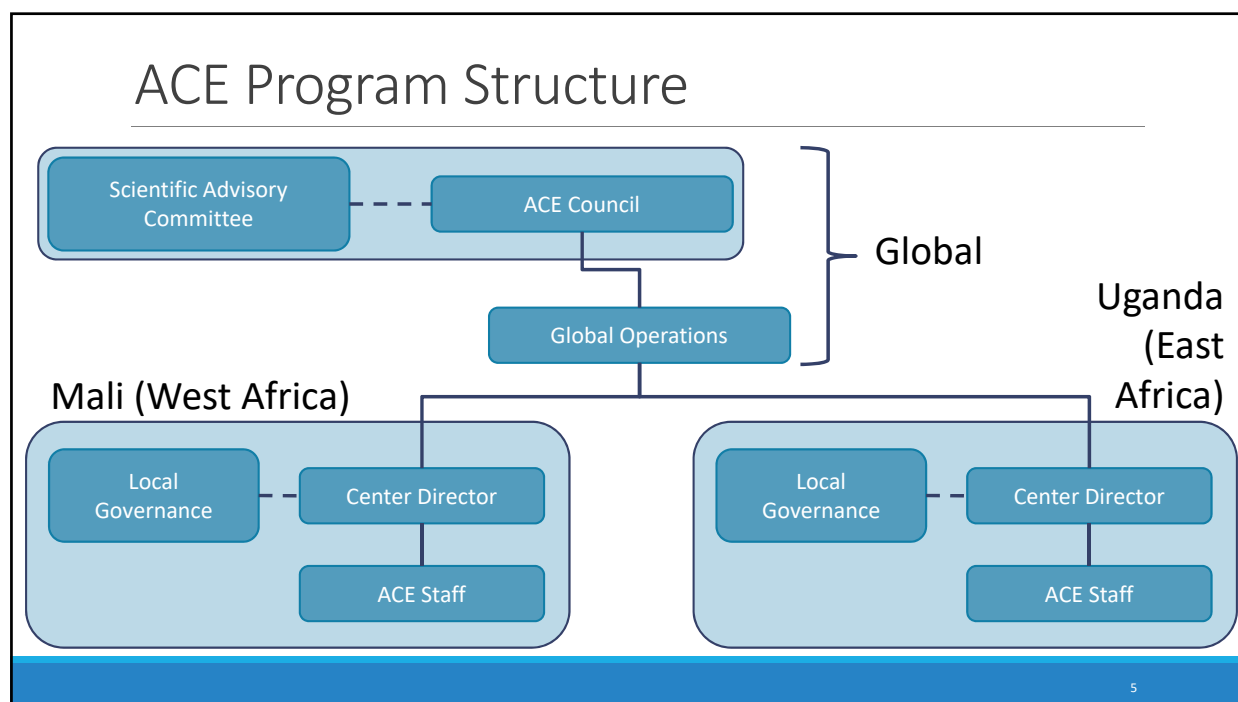to support biomedical research for infectious diseases through regional centers of excellence.

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ACE Program Features

1. **University Education**

3. **Regional Service Centers**

2. Program-Facilitated Post-Graduate Training

— — — — — **Infrastructure** — — — — —

In-kind donations from public-private partners

Self-sustaining through contributions by grant recipients

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ACE Program Structure

Scientific Advisory Committee — ACE Council

Global

Global Operations

Uganda (East Africa)

Mali (West Africa)

Local Governance — Center Director

ACE Staff

Local Governance — Center Director

ACE Staff

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ACE-Mali Center: 2015-Present

Features

- **Supports researchers** from various programs on the campus including ICER Mali, DELGEME, UCRC, and international collaborators on advanced biomedical data analysis
- Provides onsite and distance **training** to students and researchers
- Provides **high performance computing** infrastructure and training to local researchers from various departments at University of Science Techniques USTTB
- **Optimized** for regional needs
- Leverages existing **infrastructure** and decades of collaboration

Objectives

- Prove the public-private partnership
- Build the infrastructure
- Train-the-trainer
- Establish the educational element of the program
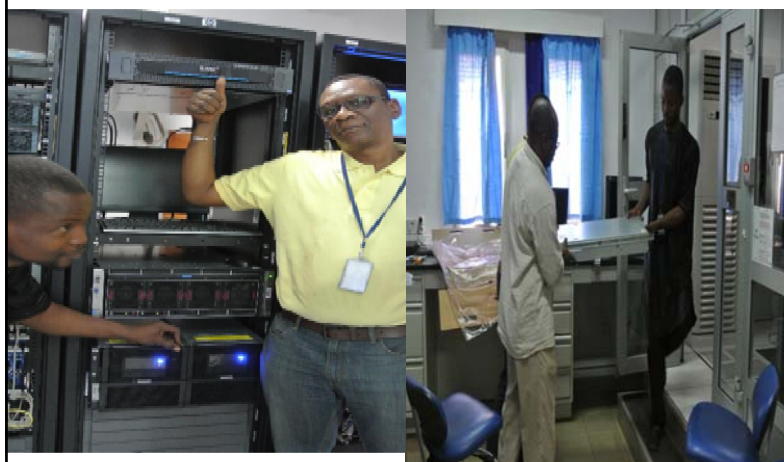- Operate the infrastructure
- Observe the outcomes

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MARCH 30 – APRIL 1

AFRICAN CENTER OF EXCELLENCE IN BIOINFORMATICS (ACE) WORKSHOP

ACE-Mali Partners

Total initial investment valued at ~$750,000

(intel)

National Institute of Allergy and Infectious Diseases

BIOTEAM
Enabling Science

EMC²

hp

Universite des Sciences, des Techniques et des Technologies de Bamako

FNIH
Foundation for the
National Institutes of Health

BioCompACE

BioCompACE asscess

On-site
◦ Thin clients in **Tele-Learning Center** hook directly into BioCompACE

Remote login
◦ Using x2go

Thin Client   Thin Client   Thin Client   Server

BioCompACE

64 Intel® Xeon® hyperthreaded **CPU** cores
1 TB **RAM**
384 TB **storage** area network (SAN)
1 NVIDIA® GRID K2 **GPU** (3072 cores, 8 GB)
EMC Avamar **backup** system

Next-Gen Sequencing
Bowtie2, BWA, CEAS, Cufflinks, cummeRbund, DESeq, DEXSeq, easyRNASeq, edgeR, GATK + Queue, GATK resource bundle, GMAP/GSNAP, iGenomes, IGV, limma, MACS, MEME, picard, RSEM, samtools, SnpEff, SOAPdenovo2, TopHat, Trinity, UGENE-NGS, USeq

Sequence Analysis
BLAST standalone plus blastdb's (db + appl.), Cross_Match, Phred, Phrap, Consed, EMBOSS, gap4 and gap5 (Staden package), MIRA, RepeatMasker, tracer, JalView, Muscle

Structural Biology
AceMD, APBS, AutoDock Tools, Chimera, I-TASSER, Ligand Expo, NAMD, Open Babel, PDB, PDB2PQR, ProDy, PyMOL, VINA, VMD, Zinc

Evolutionary Biology
BEAST, DendroPy, figtree, Garli, HyPhy, PHYLIP, MrBayes, MEGA

Biological Networks
Cytoscape, Reactome

Programming
Anaconda, Python, R, RStudio

Statistics
R/Rstudio, spss

Graphics
Inkscape, Blender

Workflow
Galaxy

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ACE-Mali Tele-Learning Facility

- 15 workstations connected to the server using a Microsoft Remote Desktop Protocol

- Two displays were installed at the front of the classroom: an 85 inch LED LCD and a smaller 40 inch LED LCD on the side.

- The side unit provides an image of the presenter

- Facilitates onsite and distance learning

| Energy | Audio | Visual | Network |

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USTTB Masters Program

- Training conducted by **local instructors** and experts from collaborating instutions : UCT, Covenant university, Institut Pasteur Tunis

- NIAID staff provides weekly **supplemental remote seminars** to reinforce content on programing, genomics and molecular modeling

- The Master's program at USTTB is divided into four semesters
  - The fourth semester dedicated to a research project on a topic chosen by the student
  - The program curriculum was developed in coordination with the Human Heredity and Health in Africa consortium (**H3 Africa**)

Semester 1
Mathematics for Biological Sciences
Structural Biology
Biostatistics
English for Scientists
Genomics and Proteomics
Cellular and Molecular Biology

Semester 2
Sequencing Techniques
Sequence Analysis
Databases
Bioinformatics for Genomics & Post-Genomics
Molecular Modeling
Programming for Bioinformatics

Semester 3
Development of Therapeutic Targets
Phylogenetics
Bioinformatics Tools for Public Health
Research Methodology
Practicum
Laboratory Internship
Scientific Communication

Semester 4
Thesis Project

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Outcomes: First Masters Cohort (2015-2017)

Name	Thesis	Post-Graduate
1 Modibo Kouyate	Bioinformatics approach in the search for priority genes as associated to neuropsychiatric disorders: the case of Autism spectrumdisorder	Research assistant, neuroscience dept. NIH funded project
2 Assetou Diarra	Genomic and molecular characterization of bacteria populations observed in the water of breeding sites and in larvae of Anopheles coluzzii and Anopheles gambiae in Nanguilabougou and Kouroubabougou	PhD student, DELGEME fellowship
3 Mamadou Coulibaly	Collection of biological data on mobile devices in the epidemiological surveillance of Malaria in Koila Bamanan and Dangassa(Mali): Development of an Android application	Database manager at UCRC
4 Almamy Koita	Construction of a combined metabolic network for A.gambiae and the malaria parasite, P. falciparum and flux balance analysis	Research assistant in the department of Public Health
5 Kangaye Diallo	Design and development of an application for database management and bioinformatics tools in Laborem-Biotech	PhD student at FST, USAID scholarship
6 Sibiry Samake	Development of a Multi-epitope vaccine candidate based on sand fly salivary proteins against leishmaniasis	Research Assistant at UCRC with Dr Seydou Doumbia
7 Fatoumata Fofana	Identification of Human and Malaria parasite protein interactions based on Short Linear Motifs(SLIMs)	Research assistant at FST, working with Dr Cisse
8 Abraham Poudiogo	Mutations associated with antiretroviral resistance among people living with HIV	Working with the the United Nations in Mopti

Outcomes: Second Masters Cohort(2017-2019)

Name	Thesis	
1 Leotard Sima Owono(Gabon)*(DELGEME)	Population structure and genome wide signatures of selection in *P. falciparum* population from Gabon (pending defense)	
2 Oumar Dolo	METAGENOMIC ANALYSIS OF THE INTESTINAL MICROBIOME IN HEALTHY INDIVIDUALS IN BAMAKO, MALI(defended)	Looking for PhD funding
3 Mamadou Dembele	Frequency distribution of Human IL10 promoter haplotype in Malian population(pending defense)	
4 Abdoulaye Diawara	A Genome-Wide association study reveals a novel genetic marker for type II diabetes in rural Uganda(defended)	Internship at Tulane University. Looking for funding to generate genomic data from Mali
5 Josue Togo	Polymorphisms of ESAT-6 and CFP-10 genes of principal strains of M. Tuberculosis senso-stricto in Mali from Whole Genome Sequence(defended)	Internship at Tulane University
6 Mamadou Sangare	Identification of *Plasmodium falciparum* therapeutic target and buiding of its model(defended)	Interested in drug design. Currently working with Dr Cisse on a PhD project
7 Moussa Kanoute	Genomic and bioinformatics characterization of Plasmodium falciparum strains collected from candidate two vaccine testing sites in Mali (Bancoumana and Sotuba)(pending defense)	
8 Ramata Mariko(DELGEME)	Copy number variation of plasmepsin II-III(defense pending)	
9 Brehima Diallo	In silico analysis of SNPs associated with knockdown resistance (kdr) in disease vectors(pending defense)	
10 Aissata Doumbia	Study of the prevalence of non-falciparum species in parasites sequences presumed to be falciparum after microscopic diagnosis (defense pending)	
11 Bourama Traore	Genomic analysis of cutaneous leishmaniasis(pending defense)	
12 Siaka Fomba	Does not have a topic yet	
13 Karfa Keita	Identifying distinct candidate genes associated with Parkinson disease for single	

Outcomes:
Third Masters Cohort
(2018-2020)

Names
1 Sekou Bagayoko
2 Oudou Diabate
3 Abdoulaye Dicko
4 Mohamed Maiga
5 Aissata Maiga(DELGEME)
6 Denis NIYOMWUNGERE(Burundi)*(DELGEME)
7 Seyba Sissoko
8 Djeneba Sissoko
9 Sounkou Toure
10 Oumar Traore
11 Brenda Udosen(Nigeria)*

In their second semester

*INTERNATIONAL STUDENTS

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Outcomes: Bionformatics Consulting

•Developing Excellence in Leadership and Genetic

Training for Malaria Elimination (DELGEME)

•Neurogenetics diseases: Clinical and genetic studies

of hereditary neurological disorders in Mali

•Immunogenetics and Parasitology
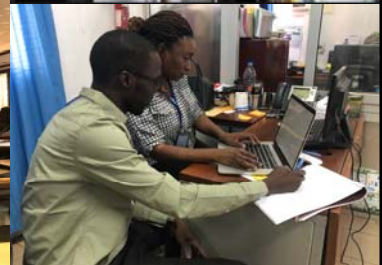
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Outcomes: Training Workshops

- The first bioinformatics " train the trainers " workshop April10th-14th **2017**
  - ➢ 30 faculties (in 2 sessions)
  - ➢ Instructors from the Laboratory of Bioinformatics, BioMathematics and biostatistics at the Institute Pasteur of Tunis
  - ➢ Topics:
    - ✓ General bioinformatics concepts
    - ✓ Sequence alignment and phylogeny
    - ✓ Networking using cytoscape
    - ✓ Sequence analysis using R

- The 2nd Bioinformatics workshop: "R workshop" March27th -30th **2018**
  - ➢ Topic :
    - ✓ Statistical analysis using R

- Workshop on GIS and NGS : March 12-22nd , **2019**:
  - ➢ 15 participants from USTTB and others Malian institutions : centre d'infectiologie charles merieux
  - ➢ Young faculties and researchers interested in Next- Generation Sequencing (NGS) and Geographic Information Systems (GIS)
  - ➢ Other countries

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Outcomes: Scientific Symposia

African Centers of Excellence in Bioinformatics Symposium; April **2015**

African Association for Research and Control of Antimicrobial Resistance(AARAM) congress:26- 28 February **2018**

"Bioinformatics for Global Health" March 11th-12th **2019**

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Outcomes: Scientific Conference Presentations

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Outcomes: Grants & Awards

- Grants that have benefitted, directly or indirectly, from ACE-Mali
  ○ 1 U2R TW010679-01: West African sustainable leadership and innovation training in bioinformatics research
  ○ 2U24HG006941_06: H3Abionet
  ○ D43 TW010350-01: HIV and mycobacterial disease in Mali
  ○ 2D43TW008652-06A1: Research training program on control of malaria and neglected tropical diseases in Mali
  ○ H3Africa 2 U01 HG007044-05: Clinical and genetic studies of hereditary neurological disorders in Mali
  ○ H3Africa 1 UO1 HG009716-01: Hearing impairment genetics studies in Africa (HI-GENES)
  ○ GZ-KO-3678/5-1: Identifying genes being central for the induction of the immune response in the midgut of *P. falciparum*-infected *A. gambiae*
  ○ 1U19AI129387-NIH: The West African International Center for Excellence in Malaria Research (ICEMR)

- NIH Director's Award 2016

"West African Center of Excellence for Global Health Bioinformatics Research Training"
Originally presented by **Seydou Doumbia**
ISCB Africa ASBCB Conference on Bioinformatics; Entebbe, Uganda, October 10–13, 2017

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Outcomes: Lessons Learned

Philosophical

- Important for students to work on systems similar to what they'll have in professional work

- The **student is a stakeholder** who both benefits and can provide

- Patience!

Technical

- Simplify

- Redundancy

- Plan for power failures & network interruptions

Pedagogical

- Educational systems vary from country to country

- Importance of **hands-on learning** over lectures
  - Cluster computing
  - Peer learning
  - Learning Management System (LMS)

- Lab rotation

Practical

- Have a **local technical resource** to assist with hands-on distance learning and to engage research community

- Local instructors are key
  - Should be coordinated locally
  - Should maximize usage of new resources – **train the trainers**

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Summary and Acknowledgements

- The ACE Program has:
  - demonstrated the value and utility of public-private partnerships to build sustainable scientific capacity
  - produced well-trained graduates who are able to pursue post graduate training, to work in their field
  - stimulated modern approaches to research
  - generated new streams of funding for scientists and their institutions

- For me, personally, the ACE Program has:
  - enabled me to pursue my PhD through financial support provided by the DELGEME grant
  - afforded me a job opportunity in support of ACE, which enabled my return to my home country

DELGEME
Training Leaders for a Malaria-free Africa

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