

Human Evolutionary Genetics
Université Paris Cité – Magistère Européen de Génétique
MNHN – Classes du Muséum

December 9 to 13, 2024

Musée de l'Homme – 17 place du Trocadéro, 75016 Paris
Metro Line 6/9 : Trocadéro
Room **Levi-Strauss**

Paul Verdu
HEG coordinator

Directeur de Recherche au CNRS
Anthropology and Population Genetics
UMR7206 Eco-anthropology
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Evaluation : Written exam, 2h. Documents, computer, and internet connexion allowed.
Total hours : 30h + 2h15 discussion/debate

Teaching Format : Conferences + Discussions/Debates

Aims :

Understand the influence of evolutionary forces on the extant and past genetic diversity of our species.
Understand the methods used in paleogenomics and human population genetics, their principles and their limits.
Understand how scientific proof is deployed in human evolutionary genetics.

Synthetic outline :

- Introduction to the study of human evolution and the theory of evolution, from paleoanthropology to population genomics through paleogenomics: The Humanity of humanity – The evolution of Evolution.
- Evolutionary forces and their influence on present and past human genetic diversity: Mutation, Demography and Migration, Selection, Culture.
- Human genetics, identity, health, ethics, deontology, politics and social challenges.

Teaching format :**« Theoretical Classes »:**

Lectures presenting the principles and methods for studying human genetic diversity and the evolutionary history of our species, within the framework of the synthetic, neutralist and neo-Darwinian, theory of evolution.

« Empirical examples » :

A researcher specifically presents his or her work based on a limited number of articles in which he or she very actively participated or closely supervised. The articles chosen must echo previous lessons, but must not anticipate the following ones other than as a conclusion/opening. The objective here is to really follow step by step the construction of an article by focusing on the data and their acquisition from the field, at the bench, and by descriptive statistical methods to end with inference methods. It is not a question of multiplying the results, even major and exciting ones, but of making people understand how the results are obtained. A single article or a very limited number of articles on the same subject must be dissected. The objective is to embody research work and the scientific method through the work of researchers, not to exhaustively synthesize all the major results in the field.

« Discussion – Debate »:

Open discussion with students. The speakers answer questions and participate in the debate. A few images can serve as a support to initiate discussions, but no lectures.

Evaluation- Exam :

Article reverse-engineering exercise of your choice.

From a long fictitious abstract but not very detailed in terms of methods, the student must imagine a Materials and Methods part which would have made it possible to produce the article according to the plan: “Population samples”, “Genetic or Paleogenetic data” , “Descriptive analyses”, “Inference methods”, and associate the questions asked for each analysis.

Several Abstracts will be offered but the student will only choose one.

The goal is not to find the exact numbers, but their orders of magnitude.

The goal is not to find the exact genetic data, but the relevant types of data.

The goal is not to find the software, but the method classes or their main ideas.

A 40-minute exemplification session of the expected exercise is planned before the exam.

Lecturer list and hours provided

Céline Bon

Maitre de Conférences au MNHN
Paléogénomique
UMR7206 Eco-anthropologie
MNHN-CNRS-Université Paris Cité
celine.bon@mnhn.fr

-> **6h = 3h45 Classes + 2 debates 2h15**

Raphaëlle Chaix

Chargée de Recherches au CNRS
Anthropologie Génétique
UMR7206 Eco-anthropologie
MNHN-CNRS-Université Paris Cité
raphaelle.chaix@mnhn.fr

-> **3h Classes**

Florent Détroit

Maitre de Conférences au MNHN
Paléo-anthropologie
UMR7194 Histoire Naturelle des Humanités Préhistoriques
MNHN-CNRS
florent.detroit@mnhn.fr

-> **2h15 = 1h30 Class + 1 debate 45min**

Flora Jay

Chargée de Recherche au CNRS
Bio-informatique, Biostatistiques et Génétique des populations
Laboratoire Interdisciplinaire des Sciences du Numérique
Université Paris Saclay-CNRS-INRIA
flora.jay@lri.fr

-> **1h30 Class**

Guillaume Laval

Chargé de Recherche à l'Institut Pasteur
Génétique de l'Evolution Humaine
UMR2000 Génomique évolutive, modélisation et santé
Institut Pasteur-CNRS-Université Paris Cité
glaval@pasteur.fr

-> **1h30 Class**

Etienne Patin

Chargé de Recherche au CNRS
Génétique de l'Evolution Humaine
UMR2000 Génomique évolutive, modélisation et santé
Institut Pasteur-CNRS-Université Paris Cité
epatin@pasteur.fr

-> **4h30 Classes + 1 debate 1h30**

Lluis Quintana-Murci

Professeur à l'Institut Pasteur
UMR2000 Génomique évolutive, modélisation et santé
Institut Pasteur-CNRS-Université Paris Cité

Professeur au Collège de France
Titulaire de la chaire Génomique humaine et évolution

Membre élu de l'Académie des Sciences
Section Biologie humaine et sciences médicales
<https://www.college-de-france.fr/fr/chaire/lluis-quintana-murci-genomique-humaine-et-evolution-chaire-statutaire>

-> **1h30 Carte blanche**

Paul Verdu (HEG coordinator)

Directeur de Recherche au CNRS
Anthropologie et Génétique des populations
UMR7206 Eco-anthropologie
MNHN-CNRS-Université Paris Cité
paul.verdu@mnhn.fr

-> **12h25 = 7h30 Class+ 2h40 Exam & PrepExam + 2 debates 2h15**

Monday – Introduction to the study of human evolution

Date and Hour	Title	Lecturer	Thematics
Monday 09/12/2024 9h00 -> 9h15	Introduction and practical information	Paul Verdu Directeur de Recherche au CNRS Anthropologie et Génétique des populations UMR7206 Eco-anthropologie MNHN-CNRS-Université Paris Cité paul.verdu@mnhn.fr	Acces to the site of the MdH – Security and evacuation routes – Overview of the schedule
Monday 09/12/2024 9h15 -> 10h45	Humanity of humanity : human diversity over time	Florent Déroit Maitre de Conférences au MNHN Paléo-anthropologie UMR7194 Histoire Naturelle des Humanités Préhistoriques MNHN-CNRS florent.detroit@mnhn.fr	<i>Theoretical classes :</i> <i>Homo sapiens</i> in the bush of hominids. Categorization, criteria of categorization and methods in paleoanthropology.
<i>10h45-11h00: pause</i>			
Monday 09/12/2024 11h00 -> 12h30	Fundamental principles of the Synthetic, Neutralist and Neo-Darwinian, Theory of Evolution	Paul Verdu	<i>Theoretical classes :</i> Fundamentals of the theory of evolution. History and construction from Darwin to Kimura. Mutation, Demography, Selection and Culture, the 4 fundamental forces of evolution.
<i>12h30-14h00: pause déjeuner</i>			
Monday 09/12/2024 14h00 -> 15h00	Paleogenetics in the Theory of Evolution	Céline Bon Maitre de Conférences au MNHN Paléogénomique UMR7206 Eco-anthropologie MNHN-CNRS-Université Paris Cité celine.bon@mnhn.fr	<i>Theoretical classes :</i> Paleogenetics : a new discipline ? Introductions to the principles, methods and limits of Paleogenetics (molecular and bioinformatics)
Monday 09/12/2024 15h00 -> 16h15	Modern and ancient human genetic data in fundamental research: introduction to ethical and deontological issues	Paul Verdu, Céline Bon	<i>Theoretical classes :</i> Declaration of Helsinki, community involvement, GDPR, Respect due to human remains, PAOHCE Large genetic databases (ancient and modern DNA) issues of data sharing and Open Science, scientific policy and economics, etc.
<i>16h15-16h30: pause</i>			
Monday 09/12/2024 16h30 -> 17h15	Discussion - Debate	Céline Bon, Florent Déroit, Paul Verdu	<i>Discussion - Debate :</i> What is the human species? How do you define a species?
Monday 09/12/2024 17h15 – clos. MdH	Free visist of the Musée de l’Homme		

Tuesday – Evolutionary forces : Mutation, Demography and Migration

Date and Hour	Title	Lecturer	Thematics
Tuesday 10/12/2024 9h15 -> 10h00	Mutation	Paul Verdu	<i>Theoretical classes :</i> The different types of mutations. Mutation as a driving force of evolution.
Tuesday 10/12/2024 10h00 -> 10h45	Demography – Effective population size and Genetic Drift	Paul Verdu	<i>Theoretical classes :</i> What is effective population size? How does genetic drift influence the genetic diversity of populations?
<i>10h45-11h00: pause</i>			
Tuesday 10/12/2024 11h00 -> 12h30	Demography – Demographic changes, isolations, migrations and genetic admixture	Paul Verdu	<i>Theoretical classes :</i> How changes in effective population size, isolation, migration and genetic admixture influence genetic diversity. Focus on admixture processes.
<i>12h30-14h00: pause déjeuner</i>			
Tuesday 10/12/2024 14h00 -> 15h30	<i>Homo sapiens</i> peopling history: the Out of Africa	Paul Verdu	<i>Empirical examples :</i> Human genetic diversity at a worldwide and genome-wide scales. An African origin of the genetic diversity of <i>Homo sapiens</i> . The Out of Africa and the serial founder model.
<i>15h30-15h45: pause</i>			
Tuesday 10/12/2024 15h45 -> 17h15	<i>Homo sapiens</i> peopling history: archaic admixture in human lineages	Flora Jay Chargée de Recherche au CNRS Bio-informatique, Biostatistiques et Génétique des populations <i>Laboratoire Interdisciplinaire des Sciences du Numérique</i> Université Paris Saclay-CNRS-INRIA flora.jay@lri.fr	<i>Empirical examples :</i> Detecting ancient admixture in current genomes. History of ancient admixture between Sapiens, Neanderthals and Denisovians.

Wednesday – Evolutionary forces : Selection

Date and Hour	Title	Lecturer	Thematics
Wednesday 11/12/2024 9h15 -> 10h45	Selection – Introduction	Etienne Patin Chargé de Recherche au CNRS Génétique de l'Evolution Humaine <i>UMR2000 Génomique évolutive, modélisation et santé</i> Institut Pasteur-CNRS-Université Paris Cité epatin@pasteur.fr	<i>Theoretical classes :</i> The different types of natural selection and their expected signatures on genetic diversity
<i>10h45-11h00: pause</i>			
Wednesday 11/12/2024 11h00 -> 12h30	Selection – Detection methods	Etienne Patin	<i>Theoretical classes :</i> How to detect signatures of selection in human genomes.
<i>12h30-14h00: pause déjeuner</i>			
Wednesday 11/12/2024 14h00 -> 15h30	Selection - Examples	Guillaume Laval Chargé de Recherche à l'Institut Pasteur Génétique de l'Evolution Humaine <i>UMR2000 Génomique évolutive, modélisation et santé</i> Institut Pasteur-CNRS-Université Paris Cité glaval@pasteur.fr	<i>Empirical examples :</i> Identify past selection events in modern human genomes. Recent selective sweeps in the history of our species.
<i>15h30-15h45: pause</i>			
Wednesday 11/12/2024 15h45 -> 17h15	Selection - Examples	Etienne Patin	<i>Empirical examples :</i> Reconstructing human evolutionary history from genomic and paleogenomic data: genetic adaptations to infectious diseases and increased risk of inflammatory diseases.

Thursday – Evolutionary forces : Culture

Date and Hour	Title	Lecturer	Thematics
Thursday 12/12/2024 9h15 -> 10h45	Culture as a fundamental force of evolution and one of its powerful mechanisms: genetic admixture	Paul Verdu	<p><i>Theoretical introduction :</i> Defining Culture for Human Population Genetics.</p> <p><i>Empirical examples :</i> How segregation and discrimination influence current genetic diversity and human evolution, 2 case studies: i) history of the so-called “Pygmies” and “non-Pygmies” populations in Central Africa; ii) history of admixture in Cabo Verde in the context of the slave trade</p>
<i>10h45-11h00: pause</i>			
Thursday 12/12/2024 14h00 -> 15h30	Culture as a fundamental force of evolution: social organization and the rule of filiation	Raphaëlle Chaix Chargée de Recherches au CNRS Anthropologie Génétique UMR7206 Eco-anthropologie MNHN-CNRS-Université Paris Cité raphaelle.chaix@mnhn.fr	<p><i>Empirical examples :</i> The rule of filiation and genetic diversity: from present to past, from past to present.</p>
<i>12h30-14h00: pause déjeuner</i>			
Thursday 12/12/2024 15h45 -> 17h15	Culture as a fundamental force of evolution: social organization and the rules of alliance	Raphaëlle Chaix	<p><i>Empirical examples :</i> Rules of alliance and genetic evolution of populations: at the crossroads between Culture, Demography, and Selection.</p>
<i>15h30-15h45: pause</i>			
Thursday 12/12/2024 11h00 -> 12h30	Reconstructing the influence of Culture on the genetic diversity of past populations	Céline Bon	<p><i>Empirical examples :</i> What paleogenetics tells us about population movements, social structures and funerary practices in Eurasia.</p>

Friday – Debate, synthesis et exam

Date and Hour	Title	Lecturer	Thematics
Friday 13/12/2024 9h15 -> 10h45	Discussion - Debate	Paul Verdu, Céline Bon, Etienne Patin	<i>Discussion - Debate :</i> Races, commercial DNA tests and human genetic diversity – political use of genetic and paleo-genetic data: societal, identity and public health issues
<i>10h45-11h00: pause</i>			
Friday 13/12/2024 11h00 -> 12h30	Carte blanche à	Lluis Quintana-Murci Professeur à l'Institut Pasteur <i>UMR2000 Génomique évolutive, modélisation et santé</i> <i>Institut Pasteur-CNRS-Université Paris Cité</i> Professeur au Collège de France <i>Titulaire de la chaire Génomique humaine et évolution</i> Membre élu de l'Académie des Sciences <i>Section Biologie humaine et sciences médicales</i> https://www.college-de-france.fr/fr/chaire/lluis-quintana-murci-genomique-humaine-et-evolution-chaire-statutaire	<i>Carte Blanche</i>
<i>12h30-14h00: pause déjeuner</i>			
Friday 13/12/2024 14h00 -> 14h40	Exam preparation	Paul Verdu	Exam preparation exercise, last minute questions
<i>14h40-15h00: pause</i>			
Friday 13/12/2024 15h00 -> 17h00	Exam	Paul Verdu	In-person written exam, copies to be returned at the end of the exam. All documents authorized, internet access authorized.
Friday 13/12/2024 17h00 -> 17h15	Evaluation of the module by students	Paul Verdu	An evaluation questionnaire is to be completed by the students
END of the module HEG			