Master in Epidemiology – UA

- Organization of course:

  Work around a Lancet paper series from 2005:
    1. Key concepts in genetic epidemiology
    2. Genetic linkage studies
    3. Genetic association studies
    4. What makes a good association study?
    5. Shaking the tree: mapping complex disease genes with linage disequilibrium
    6. Population-based family studies in genetic epidemiology
    7. Genetic epidemiology and public health: hope, hype, and future prospects

  In particular, the aforementioned 7 papers (given prior to the class series as mandatory reading) serve as a starting point. However, since 2005 several new insights were gained and new developments emerged. During the contact hours, we will cover some of the key concepts explained in the reference papers, as a means to highlight current advances in the field. The students are invited to form groups and to prepare a work document (via guiding questions) on one of the hot topics related to the course. This assignment may involve a literature search on the topic, and an exposé on how it relates to the topics covered in class. The group presents this work in class, after which a discussion is stimulated and additional explanations are provided by the course instructor. The goal of the class discussions is to nourish an elaboration on concepts and themes that are relevant in the context of modern and future genetic epidemiology.

Detailed outline:

Day	Topic	Approx # hrs
Mo 18/3/2013	**Intro / Molecular genetics / human genetics / genetic epidemiology –** Assignment 1 on "epigenetics"; 20/100 of final score; report due date to be discussed; presentation on Tue 26/3 GROUP score	6 hours
Thu 21/3/2013	**Population genetics** **In-class reading with discussion** **Showcase of "how to find reliable genetic epi information on the web"**	4 hours
Fri 22/3/2013	**Population-based association studies**	6 hours
		16 hours
Mo 25/3/2013	**Population-based association studies –** **Showcase of useful software tools for genetic association studies (population-based) –** Assignment 2 on " association studies"; 25/100 of final score; due date to be discussed GROUP score	4 hours
Tue 26/3/2013	**Family-based association studies –** **Showcase of useful software tools for genetic association studies (family-based) – bring laptop to class** **In-class reading with discussion** (time permitting)	6 hours
Thu 28/3/2013	**Traveling a world of interactions –** Assignment 3 on "pharmacogenomics"; due date = the exam INDIVIDUAL score	6 hours
~~Fri 29/3/2013~~	~~From linkage to omics integrated analyses~~ ~~Questions and answers – recapitulation of Genetic Epidemiology highlights~~	~~4 hours~~
		20 hours
Exam format	[Individual] oral presentation of individual report (compilation of projects 1,2,3) + additional questions making links to the course content; 30/100 (individual written report, compilation of projects 1,2,3) + 25/100 (answers to questions related to oral presentation/exam) of final score; date to be discussed	

Some relevant questions that may be addressed during the course:

- **Molecular genetics: taxonomy** (revisited)
  Historical notes about genetic epidemiology (What is it? How did it emerge? What are challenges? What are typical analyses / research questions in genetic epidemiology? What is the analysis flow in a genetic epidemiology framework? – Relates to Paper 1
  → assignment 1 on "epigenetics"
- **Population Genetics** (what are the relevant concepts? How can population genetics contribute to improved gene mapping? HWE, LD? How to characterize subpopulations? How to identify subphenotypes (molecular reclassification of patients) – Relates to Paper 5
- **Population-based Genetic Association Studies** (what are they? Consequences of scaling up: from genetics to genomics, from candidate gene to genomewide) – Relates to Papers 3, 4
  → assignment 2 on "integrating linkage in genetic association studies" (use Paper 2
   to familiarize with concepts, encountered during the literature search)
- **Family-based Genetic Association Studies** (what are the pros and cons of using families? Are the hurdles the same as in general epidemiology? Scaling up from candidate gene to genomewide screens, clever ways to reduce the burden of multiple testing) – Relates to Paper 6
- **Travelling a world of "interactions": gene-gene and gene-environment** interactions (how to capture gene-gene and gene-environment interactions? Is the regression framework sufficient? Why is it important to investigate interactions? Links with pharmocogenetics and epigenetics)
      → assignment 3 on "pharmacogenetics as part of genetic association interaction
       studies"
- **From linkage analysis to omics integrated analyses for better diagnostics and improved health** (which information to integrate with "classic" genetic epidemiology studies? How to integrate this information? Where to integrate it? What is the role of genetic epidemiology in the post-genomic era? Public health genomics versus personalized medicine? Direct-to-consumer personal genome testing?) – Relates to Paper 7
  → exam details

Key concepts (important for oral exam / learning outomes):

- **Molecular genetics: taxonomy**
  Genes, alleles, haplotypes, chromosomes, genetic distance, physical distance, recombination, allelic association
- **Historical notes about genetic epidemiology**
  Aggregation, segregation, genetic models
- **Population Genetics**
  Population structure, linkage disequilibrium, Hardy-Weinberg equilibrium,
- **Genetic Association**
  Parametric linkage, non-parametric linkage, odds ratios, estimating relatedness, association tests, case-control associations
- **Gene-gene and gene-environment interactions**
  Epistasis, epigenetics, nature versus nurture, effect modification, confounding

Overview of class course content / class schedule "genetic epidemiology – 2012/2013 @ ULg-UA

Course Name	Date	Class	Topic
PH20-20	13/02/2013	COURSE PH1+2	intro, setting pace, concepts in molecular biology + identify topics (will give examples online from last year)
PH20-20	20/02/2013	COURSE PH3+4	Genetic Epi and Population Genetics + Assignment Presentations 1
BIOINF15-15	*05/03/2013*	*COURSE 1+2* *Assignments: split up the work and generate one report per group*	*Intro, setting pace, epidemiology in R – concepts in epidemiology (finding resources), highlight the variation in available tools such as the FBAT software, R SNPassoc and GenABEL, PLINK* *Assignment1: e.g., what are the key properties of these software packages*
PH20-20	06/03/2013	COURSE PH5+6	Presentations of homework 1 and genetic association studies
UA	18/03/2013	CLASS 1	Intro in genetic epidemiology
BIOINF15-15	*19/03/2013*	*COURSE 3+4*	*Quality control: genome-wide association studies, confounders, environmental effect modificators (i.e., quality control of environmental constructs)* *Assignment 2: Compare quality control measures in PLINK with those available via GenABEL (or R in general), look up the theory behind, report, discuss + when using the same QC-ed data, perform an association study in GenABEL and PLINK (compare the results, are they different or the same and why?)*

PH20-20	20/03/2013	COURSE PH7+8	Genomewide association studies and epigenetics
UA	21/03/2013	CLASS 2	Population genetics
UA	22/03/2013	CLASS 3	Population-based genetic association studies (50 from 150 pages)
UA	25/03/2013	CLASS 4	Population-based genetic association studies (100 from 150 pages) How to do it in practice: showcase of practical analysis tools (time permitting)
UA	26/03/2013	CLASS 5	Family-based genetic association studies How to do it in practice: showcase of practical analysis tools
PH20-20	27/03/2013	COURSE PH9+10	Epidemiology of interactions + Assignment Presentations 2
UA	28/03/2013	CLASS 6	Traveling a world of interactions
~~UA~~	~~29/03/2013~~	~~CLASS 7 (?)~~	~~From linkage to omics integrated analyses (recap class?)~~
BIOINF15-15	*15/04/2013*	*COURSE 5+6*	*Pedigrees or not? (linkage versus association, family-based association tests, families and next generation sequencing) Showcase in class of how FBAT works Assignment 3: Perform a GenABEL analysis and compare with results obtained from FBAT, report and discuss*
PH20-20	24/04/2013	COURSE PH11+12	Presentations of homework 2 and closure with personalized medicine notes
BIOINF15-15	*29/04/2013*	*COURSE 7+8*	*Genome-wide association interaction analysis: theory with MB-MDR Assignment 4: Perform a*

			gene-gene interaction analysis using GenABEL and interpret your findings (annotate)