Organising institution

Università degli Studi di Padova
Dipartimento di Scienze Chirurgiche, Oncologiche e Gastroenterologiche –DISCOG
Prof.ssa Paola Zanovello

Partner Institutions

Division of Molecular Pathology, Centre for Evolution and Cancer of The Institute of Cancer Research, London, UK
Wellcome Sanger Institute, Hinxton, Cambridgeshire, UK

Course Title and Description

Genetic evolution of cancer and access to "Big Data": an introductory course

The theoretical and practical activities will be organized into 9 seminars in English

Lecture 1. Darwinian evolution (Andrea Sottoriva).
We will introduce the fundamental concepts behind Darwin's theory of evolution and how these ideas have developed in the last 150 years into the so-called 'modern evolutionary synthesis' where evolutionary biology and genetics meet to form molecular evolution and explain the evolution of species, from bacteria to humans.

Lecture 2. Clonal evolution in cancer (Andrea Sottoriva).
We will present how tumours emerge through a process of somatic evolution and how they transform from benign, to malignant, to metastatic. We will also study how this process leads to inter-patient and intra-tumour heterogeneity.

Lecture 3. Treatment resistance (Andrea Sottoriva).
Arguably the biggest problem in cancer therapy today is the emergence of resistance to treatments. We will show how evolution is the central conceptual framework to understand therapy failure, when driven by genetic, non-genetic and even non-Darwinian mechanisms.

Lecture 4. What is a cancer driver gene? (Andrea Sottoriva).
We will introduce the concept of cancer driver, how driver genes are identified and functionally validated. We will focus on DNA changes in cancer driver genes discovered by large-scale genomic studies and use cBioPortal (cbioportal.org) and IntoGen (intogen.org) to actively explore the huge amount of available data.

Lecture 5. What is a cancer vulnerability? (Francesco Iorio).
How do we identify novel drug targets in cancer by exploiting vulnerabilities of cancer cells in terms of their functional dependencies on certain genes, or their oncogene addictions. We will introduce the fundamental concepts of essentiality, dependency, and actively explore the DepMap portal (depmap.org) to learn how to extract useful information from these large-scale CRISPR and RNAi screenings.

Lecture 6. Is the right time for a next generation histopathological diagnostics? (Matteo Fassan).
How has evolved the histopathological report in the last decade with particular focus on the integration of next generation sequencing data in the clinic and the implementation of digital pathology. The evolution of the clinical impact of the pathology report in the personalized medicine era.

Lecture 7. Digital Pathology with Artificial Intelligence (Nicholas Trahearn).
We will introduce the concept of Deep Learning for image analysis. We will provide an overview of how a neural network is constructed and trained. We will demonstrate application of Deep Learning to histopathological images to automatically classify millions of single cells and construct geographical tumour maps.

Lecture 8. Using R for data analysis (Angela Grassi).
Review of some key aspects of R programming in view of the next lecture.

Lecture 9 (ADVANCED). Machine learning and population genetics methods for genomic data analysis (Giulio Caravagna).
Whole-genome sequencing is being enrolled as an instrument for precision medicine in many countries. In this advanced course, we will deep dive into the tools used to analyse genomic data in cancer, specifically whole-genome sequencing, to extract functional and clinical information in a way that can inform precision medicine. Specifically, we will use data-driven machine learning approaches combined with model-based population genetics theory (requires solid background in R and statistics).

Collaboration mechanisms: theoretical lectures, virtual exchange, guided computer labs, small work groups, debates on articles and online databases that are information sources

Period 01/10/2021 – 11/02/2022

ETCS credits N/A

Course fee N/A

Course Level PhD course in Clinical and Experimental Oncology and Immunology
Specialisation School in Medical Oncology