UNIVERSITÀ DI PISA

GENETICS, ETHNOLOGY, AND GENETIC IMPROVEMENT FOR

ROBERTA CIAMPOLINI

Anno accademico	2023/24
CdS	ANIMAL BREEDING TECHNIQUES AND DOG TRAINING
Codice	576GG
CFU	10

Moduli	Settore/i	Tipo	Ore	Docente/i
GENETICA E MIGLIORAMENTO GENETICO PER L'ALLEVATORE	AGR/17	LEZIONI	108	FILIPPO BISCARINI ROBERTA CIAMPOLINI

Learning outcomes

Knowledge

Genetics, Animal Breeding and selection For the Breeder
The student must possess the fundamentals that make him able to understand:
the basic concepts of classical genetics, , fine gene structure and molecular genetics for animal species in livestock production and pet species.
the basic concepts of Cytogenetics: normal and abnormal chromosomal patterns of the species
animals in zootechnical production and of the species of companionship.
The modern implications of molecular genetics in the methodologies of genetic evaluation of breeding animals for the genetic improvement and for the correct application of genetic selection schemes in pet species;
The modern implications of molecular genetics in the clinical field in the study of pathologies
Cat and Dog Factor Mono and Multi Factorial Genetic Base with the aim of understanding the mechanisms of eradication of pathologies
mono fatty acids through the early detection of affected, healthy and healthy carrier reproducers;

the Applications of Molecular Genetics and the procedures to be followed in the release of Pedigree
by the Italian Kennel Club E.N.C.I .: Deposit and Conservation of the
Biological Sample at Accredited Laboratories, Genomic Profile by Markers
Genomics STR, Parental Test (Execution and Interpretation).

Assessment criteria of knowledge

Genetics, Animal Breeding and selection For the Breeder
Knowledge assessment will be carried out through a written test on a computerized platform. The test will focus on the topics discussed during the frontal lessons and practical exercises carried out in the Computer Laboratory at Platform Moodle of the University of Pisa in presence. (According to the procedures established by the University of Pisa for the distancing and protection of students from Covid 19)

Skills

Genetics, Animal Breeding and selection For the Breeder
The student will be able to apply inherited transmission models for simple and complex characters and to identify hereditary cases due to extensions of Mendel's laws.
The student will be able to pick up and store the biological samples both for the purpose of screening for genetic diseases and for the required analyzes of the Italian Kennel Club E.N.C.I. for the procedures to be followed in the release of Pedigree and will be able to interpret the report of a parental test.
The student will be able to suggest to the breeder the DNA tests for prevention in dogs and cats. DNA tests for disease-causing genes allow breeders to avoid breeding dogs that could result in puppies being affected by the disease and to improve the health of their breeding stock.
The student will be able to apply the modern genetic selection schemes and will use molecular genetic testing in the screening of Pathologies for the purpose of eradicating monofactorial pathologies.

Assessment criteria of skills

Genetics, Animal Breeding and selection For the Breeder

The assessment of the skills consists of an interactive activity carried out at the computerized laboratory using the Moodle computerized platform of the University of Pisa.

Behaviors

GENETICS - Classical and Molecular Genetics
The student during the exercises should be able to interact with the classmates in the exercises planned for groups, be able to effectively understand the in-depth analysis of the exercises and the applied methodologies explained in lesson, and must behave in a conscious, critical and interactive way for the Topics covered.

Assessment criteria of behaviors

Genetics, Animal Breeding and selection For the Breeder
During practical activities, the teacher will evaluate student behavior and their ability to interact with the teacher and their companions by observing the correctness of the activities and evaluating the student's language properties.

Prerequisites

Genetics, Animal Breeding and selection For the Breeder
The student must to have basic knowledge of subjects such as Chemistry, Biochemistry and Biology

Teaching methods

GENETICS - Classical and Molecular Genetics
Lectures: 50 h lectures with the aid of slides, interactive material with a self-assessment system for learning by the student. Moodle platform University of Pisa
Practical Activities 12h
Practical activity at the "Polo Informatico 5" laboratory using the MOODLE system computerized platform of the University of Pisa. Constitution of a genomic profile by Microsatellite and SNP Genomic Markers as the ISAG International Society for Animal Genetics Protocol and Attribution of a genomic identity to an individual or biological sample for the purpose of recognition in the event of an expert report or certification of seminal material for the purpose of artificial insemination. Verification of parental tests carried out using computer simulations. **6h**
Recognition of dog breeds and attribution to the 10 FCI Groups through interactive activities and self-assessment of learning performed at the "Polo Informatico 5 Piagge" through the computerized platform of the University of Pisa's MOODLE system.**2h**
Possibility for the Student to both practice this activity and self-evaluate his preparation even remotely with any device (PC, Tablet, Smartphone)

Practical Full-class Practice and Single Group with HBDD Molecular Dogs RIS Roma Certified in Searching for Missing Persons Actually in the Subject of the Program Concerning the Genetic Bases of Dog Sense of smell **2h**
(Seminars): 2h Depth study of topics addressed during the lectures

Animal Breeding and selection For the Breeder
Lectures: 30 h lectures with the aid of slides, and interactive material with a self-assessment system for learning by the student. Moodle platform University of Pisa
Practical Activities 16h
Practical activity at the "Polo Informatico 5" laboratory using the MOODLE system computerized platform of the University of Pisa.

Syllabus

GENETICS for the Breeder
Lectures: 50 h by using PowerPoint slides
4h Introduction to the Genetics Course program.Nucleic Acids Structure, chemical composition, and function. The DNA organization in chromosomes. Size of Animal Genomes for Livestock species and dog.DNA Single-Sequence and Repeated Sequence. DNA Replication and Recombination. The Transcription. The Gene: Chemical structure, mechanisms of action, study criteria.The genetic code and the translation. The regulation of gene expression. Gene mutations, suppressor mutations, mutation rate, mutation frequency. How mutations in a gene can affect its expression.
4h Molecular Genetics Basics. Techniques of interaction with Nucleic Acids. Genomic DNA extraction from different substrates. The Electrophoresis on Agarose and Poliacrilamide Gel. DNA in vitro amplification by P.C.R. Polymerase Chain Reaction. DNA Sanger's Sequencing Methodical. Automation of Sanger Methodology The Automatic DNA Sequencers. Practical examples of applications in the canine field of laboratory techniques of interaction with Nucleic acids.
3h The Individual, Genotype, Phenotype. Theories of inheritance. Mendel's Laws: Mendel's Experiments, Mono-hybrid Cross, Data Interpretation, Punnett's Square, POLYRIDISM EXPERIENCES. The chromosomal theory of inheritance. Pedigree analysis. Extensions of the Mendelian Analysis, Heredity of Individual Genes. Protein Function Explains Dominance Phenomenon. Incomplete Dominance, Co-dominance.
4h Penetrance and Expression, Chickens Polydactyly, Environment Internal, and External, Age of Onset, Over-dominance. Multiples alleles. Inheritance of X-linked Genes. Diandria and Olandic inheritance. Pseudo Autosomal Genes, Sex Influenzed Genes. Sex Limited Genes. Lethal Alleles in Man, Sheep, Pig, Horse, Cat, and Dog. Pleiotropic Effects of Genes. Genes Modifiers and Genics Interactions. Epistasis, Complementation. Recessive Epistasis in the Labrador Breed Coat Color. Genic redundancy. Genic linkage and Exchange. The Genetic Map

Concept.
2h Extranuclear non-Mendelian inheritance. Maternal Effect, Epigenetic inheritance, Genomic Imprinting, Maternity, The Mitochondrial and Chloroplast Genome Transmission Mode. Concepts Comparation of Maternal Effect and inheritance Maternal. The Endosymbiosis Theory. Genetic Polymorphisms and Origins of DNA Polymorphisms. Definition of Genetic Polymorphism
6h Biodiversity. Definition and different Levels of Study: Genomic, Species, Ecosystemic. Genetic Variability Definition and examples. Genetic Variability From Canis Lupus Lupus to Canis Lupus Familiaris. From domestication to the creation of modern dog breeds. Canine Ethnology. The FCI classification of dog breeds is based on morpho-functional and attitudinal characteristics. The importance of subdividing dog breeds into 10 different groups and a guide to the classification of the 10 FCI Groups. The 16 Italian Dog Breeds focus.
3h Genomic Markers SNP and STR Their Use. How to Build a Genomic Profile with STR Markers and SNP Markers. How to Perform a Parental Test using STR and SNP markers. Molecular Genetics in ENCI procedures: Storage and conservation of the Biological Sample at accredited laboratories. Genomic Profiles and Parental Tests. Genomics is applied to the protection of dog breeds. Case Study: the illegal import of puppies. Forensic genomics applied to the canine species. Case Studies: The Kidnapping and Killing of a Dachshund. Kidnapping and Exploitation of a Lagotto Romagnolo.
2h The genetic basis of canine behavior and behavioral disorders.
2h The genes that influence the length of the limbs and the conformation of the skull. Chondrodysplastic races and the role of the FGF4 gene in limb length. The role of the BMP3 gene in the conformation of the skull in brachycephalic breeds.
4h The genetic basis of dog size and body conformation. The example of the study carried out in the Portuguese Water Dog breed. The particular case of the MSTN gene in the Whippet dog breed. Associations between body size and mutations present in the IRS4, ACSL4 and IGSF1 genes in different dog breeds.
2h The genetic basis of dog longevity and their correlation with body size. The correlation between telomere length and longevity. QTL CFA 7; QTL CFA 8; QTL CFA 10; QTL CFA 15; QTL CFA 34; QTL CFA 23; QTL CFA 29; QTL CFA 9.
2h The study of the genetic basis of dog hereditary diseases. Management of Genetic Diseases. Chromosomal anomalies. Monogenic diseases and study approach. Multifactorial, multigenic diseases and study approaches.
2h The Genetic Bases of the Dog's Smell. Polymorphism of the olfactory receptor genes of the dog. The Role of SNP Genomic Markers and their Polymorphism in the discriminatory capacity of the different odoriferous molecules. The polymorphism of SNP genomic markers correlates with the innate ability to recognize particular olfactory molecules.
2h The role of the IRS4, ACSL4 and IGSF1 genes in the body size of breeds weighing more than 40Kg. The genes underlying the conformation of the ear and the length and curl of the tail. The genes that influence the characteristics of the Coat. The FOXI3 gene in the Chinese Crested breed. Mutations on the CFA18 and coat of the Rhodesian Ridgeback breed. The RSPO2 gene and the Furnishing trait in Schnauzer and Scottish Terrier breeds. The role of FGF5, RSPO2, KRT71 genes in naked breeds. The SGK3 gene and non-lethality in the American Hairless Terrier nude breed pedigree analysis
2h Mapping of complex genomes and the Genomic Map of the main species in zootechnical production and of companion animals. State of the art of the genomic map of pet species. QUANTITATIVE TRAIT LOCI (QTL) MAJOR EFFECT GENES, MARKER ASSISTED SELECTION / MARKER ASSISTED INTROGRESSION (MAS / MAI) GENOTYPE ASSISTED SELECTION (GAS). RESEARCH OF QTL THROUGH THE USE OF GENOMIC MARKERS.
4h IDENTIFICATION OF THE GENES RESPONSIBLE FOR THE MAIN HEREDITARY DISEASES. The approach of MOLECULAR MARKERS for the research of the genetic bases of multifactorial pathologies, Epilepsy, Hip dysplasia, etc. The "Gene candidate approach", the case study of the PRA Progressive Retinal Dog Atrophy. Cancer Diseases. The genetic basis of tumors is related to the selection made for coat color and body size. the role of genetic tests in dog breeding. Development of a genetic test and use of genetic tests in the prevention of the appearance of a genetic-based disease and in the eradication of the disease on a farm.
4h Concepts of Cytogenetics, Methodologies, and criteria for studying chromosomes. Lyon Effect Compensation of Gene Assay, Barr Body, the Molecular Basis of X-chromosome Inactivation, Example of Coat Coloration in the Calico Cat. Karyotype and Idiogram of pet species: Normal and abnormal chromosomal arrangements. Chromosomal aberrations. Alterations in the number: polysomies and polyploidies. Meiotic and mitotic nondisjunction. Structure anomalies. Deletions. Duplications. Pericentric and paracentric inversions. Reciprocal and Robertsonian translocations. Molecular cytogenetics and modern chromosome study techniques.
Practical Activities 12 h
Practical activities at the Laboratory using the MOODLE system of the University of Pisa. Constitution and attribution of a genomic profile to an individual. Verification of parental tests performed using Microsatellite Genomic Markers. **6 h**
Practical activities at the Laboratory using the MOODLE system of the University of Pisa. The Recognition of Dog Breeds interactive teaching method with self-assessment system **2 h**

Practical Full-class Practice and Single Group with HBDD Molecular Dogs RIS Roma Certified in Searching for Missing Persons Actually in the Subject of the Program Concerning the Genetic Bases of Dog Slain **2 h**
Depth study of topics addressed during the lectures **2h**

Program course of Animal Breeding and selection For the Breeder

The concept of species and the concept of breed. Recap how modern dog breeds were created. Meaning of gene pool. The genetic Pool and its use in the creation of a breed. Population genetics. How genetic variability changes over time and space. Determination of genetic vulnerability of a canine breed using criteria developed by FAO. 2h
Understand the genetic composition of a population and the forces that determine and modify that composition. Population genetics. Concept of Allele Frequency and Genotypic Frequency. Hardy Weimberg's Law. Hardy-Weinberg equilibrium test. 2h
How to explain the Genetic Variability of a population in terms of Genetic Mechanisms: sexual selection, positive and negative assortative mating in natural populations and comparison with selective mating in the canine species the concept of Inbreeding, examples on the dog. Genetic Drift, Mutation, Synonymous and non-Synonymous Mutations, Migration. 2h
The “Bottleneck” effect, the Founder effect” Examples on dog breeds. The effect on the genetic variability of the dog populations of the "Most Popular and Winners of Beauty or Bravura Contests". Concepts of Effective Size of a Population and Effective Number. Wright's F Statistics and the analysis of genetic variability in populations 2h
The different objectives of the Selection adopted in the Canine breeds. The selective schemes adopted in the Canine Species and their effects

on the Genetic and phenotypic variability. Because it is essential to identify the action of selection at the genomic level. " 2h
The Stud books. The pedigrees. Concepts of Kinship and Consanguinity (Inbreeding) because it is important to know them for selective purposes and for the genetic health of dog breeds. Basic Kinship Measures, Kinship Coefficient, Wright Coefficient. Calculation of Additive Kinship and Inbreeding: The Tracing the Paths Method, The Tabular Method, The Additive Kinship Matrix. Examples of dog breeds. Microsatellite Markers (STR) and SNP and Genomic Kinship. 2h
The Quantitative Traits in the canine species. Phenotypic classes of quantitative traits and distribution of phenotypes. Application of the Concepts of: Mean, Variance and Standard Deviation. Standardization of a variable. Concepts of Covariance, Correlation, Regression. Analysis of Variance. 2h
Genetic Additive Variance, Genetic Variance of Dominance Genetic Variance of Interaction. Influence of environmental variability on a quantitative trait. The Concept of Heritability. Heritability estimation. Repeatability concept. Examples in dog breeds 2h
In-depth analysis on the objectives of the Selection adopted in the Dog Breeds: "Importance of the Role of the ENCI Judges in the development of the guidelines for the Selection of the Dog Breeds" 2h
In-depth analysis on the objectives of the Selection adopted in the Canine breeds: "The hypertype in the dog breeds. The example of the Small Molossers and the work of the ENCI Judges in correcting the objectives of the Selection"2h

Using population genomic data
Linear models for dog breeding and genetic structure of populations

- Variance components recap: heritability, genetic and phenotypic correlations 1h
- EBVs/GEBVs: sire and animal models 3h
- Genetic admixture, genetic distances between populations, genetic clustering 1h

Using individual genomic data
- Quantify inbreeding: from pedigrees to genomics 1h
- GWAS: identify genetic polymorphisms associated with phenotypes 1h
- Genome-enabled predictions of phenotypes 2h
- Computer-assisted diagnosis: using image data 1h

Practical Activities Total 16 h
Practical whole-class teaching held in computerized mode at the Computer Laboratory of the Department

- Software and other tools
R/Rstudio, Python/ipynb, Plink, Admixture, Beagle
Data sources and preprocessing
- sequencing and genotyping technologies
- data quality: filtering and imputation of missing data
- calculating the kinship matrix

Breeding and selection
- estimating variance components, heritability and genetic correlations between phenotypes
- models for EBVs/GEBVs
- basic models for GWAS (genome-wide association study)
- a primer to post-GWAS analysis
- models for genomic predictions

Genetic diversity and inbreeding
- estimating genetic parameters: heterozygosity, inbreeding, linkage disequilibrium
- runs of homozygosity and HRR (heterozygosity-rich regions)
- principal components analysis (PCA)
- population genetic structure and clustering

Advanced applications
- models for image recognition and computer-assisted diagnosis

Bibliography

GENETICS For the Breeder
Bology vol 2 Genetics Robert J. Booker e A. McGraw-Hill Education (Italy) srl
The material for lessons and exercises, as well as the most current bibliography on the subjects covered during the course, are available to the student in PDF format at the Elearning Platform of the Department of Veterinary Sciences. https://elearning.vet.unipi.it/

"Life: The Science of Biology" 11Edition 2017 by Oxford University Press
David Sadava, David M Hillis H. Craiig Heller and Sally Hacker
Downloadable Multimedia eBook with interactive chapters and movies that can also be viewed from a Smartphone

Animal Breeding and selection For the Breeder

UNIVERSITÀ DI PISA

Non-attending students info

GENETICS ANIMAL BREEDING AND SELECTION FOR THE BREEDER
Contact the Teacher via email roberta.ciampolini@unipi.it.
download the syllabus

Assessment methods

Final exam
GENETICS ANIMAL BREEDING AND SELECTION FOR THE BREEDER
The Exam Testing is performed in the computerized form at the Computerized Laboratory of the Polo Infomatico Piagge using the Moodle computerized platform of the University of Pisa. The task is composed of multiple-choice and closed-ended questions.
(According to the procedures established by the University of Pisa for the distancing and protection of students from Covid 19)

Additional web pages

Meet course access code: iuuh2bp

GENETICS ANIMAL BREEDING AND SELECTION FOR THE BREEDER
http://lbg.vet.unipi.it/
http://www.enci.it/

Notes

GENETICS ANIMAL BREEDING AND SELECTION FOR THE BREEDER
Receiving Students by appointment requested and agreed by email to the Teacher

Updated: 16/09/2023 18:35