

《医学遗传学》教学大纲(理论)

(授课对象：基础医学(朱宪彝班) 专业)

Preface

Genetics, one of the most rapidly progressing branches of biology, has applications that affect all of humanity. Many of the principles of genetics are universal among the vast diversity of species on earth, making it possible to apply concepts discovered in one species to other species. The concept of the gene is central to the study of genetics. Genetics, an analytical science, is best understood through a study of how genetic experiments are conducted and their results interpreted.

——Cited from 《Genetics: The Continuity of Life》

The genetics is the science of studying the organisms, heredity and variation, the science of studying the nature, function and significance of the gene. Since the Mendel heredity law has been rediscovered in 1900, the genetics has experienced the development longer than centuries, has obtained the unprecedented magnificent achievement in natural sciences history of the modern times, and has been demonstrating the strong development tendency with extreme vigor.

As people have known the role of genetic factors in the occur of human diseases, especially the formation rates of nutrition and infectious diseases have dropped markedly in the developed countries, people pay more attention to the decisive action of the inherent cause of the human diseases.

It has been demonstrated that the causes of some serious diseases such as coronary artery diseases, diabetes, hypertension and major mental illness include genetic factors. At the same time, the progresses of molecular genetics and gene mapping have promoted the rapid development of theoretical knowledge of the basic genetic. The contribution of these new progresses lies in the prevention and avoid of diseases. This direction must be the focus of modern medicine.

A world-renowned geneticist, Director of National Human Genome Research Institute of National Institutes of Health of the United States, Dr. F. S. Collins said that, "In the next few decades, the genetics will demonstrate the prominent function in the medicine mainstream practice." In the era of next generation sequencing, individualized (or precise) medicine becomes available. Medical doctors need to know much more genetics than they did 5 years ago: non-invasive prenatal testing (NIPT) and sequencing based targeted therapy became daily routine, although they were almost unheard of before 2010. Now, almost all medical colleges in China are teaching medical genetics. Indeed, Genetics or Medical Genetics became key courses of modern medical education.

The teaching goal of the genetics curriculum for medical students is to understand basic theory of genetics, to learn new achievements and new technologies in genetics, to know the relations between human heredity and the diseases, and to lay a solid foundation for the study of basic medicine, clinical medicine and practice.

In the teaching, we prominent the spirit of "new", " deep", "fine", paying attention to basic theory and elementary knowledge of genetics.

Students will be evaluated by following methods: (1) The required course examination includes two parts: the score of the final test (60%) and regular grades (40%). The grades depend on a comprehensive assessment of the experiments, assignments, reading report (review), class discussion, quizzes and independent studies. (2) The provisions of the course examination results: The test of theory class session, accounted for 60% of the total score. The experimental results account for 28% and the remaining 8% covers the assignments, reading report (review), class discussion, quizzes and 4% covers the self-directed learning.

The teaching contents in this syllabus are arranged for students of basic medicine. The class hours are 54 in total (34 for theory and 2 for self-directed learning).

Chapter 1 Introduction

1. OBJECTIVES

- (1) Know the relationship of Genetics, Human Genetics and Medical Genetics, and the brief history of Medical Genetics
- (2) Master the task and content of Genetics studying and the studying characteristic of human genetics
- (3) Master the concept of medical genetics and relationship between Genetics and Medicine
- (4) Master the concept, characteristics and types of inheritance diseases, understand the relationship of heredity and environment
- (5) Know task of medical genetics and genetic medicine
- (6) Know development direction of medical genetics in post-genomic era

2. COURSE CONTENT

- (1) Hereditary basis of health and disease
- (2) Brief history of development of Genetics
- (3) The relationship of Genetics, Human Genetics and Medical Genetics
- (4) Classification and characteristic of genetic disease
- (5) Task and prospect of medical genetics and genetic medicine

3. TEACHING HOURS

3 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 2 Cellular and Molecular Basis of Genetics

1. OBJECTIVES

- (1) Master the composition of the human genome and genetic law
- (2) Master the concept of the gene and gene expression regulation
- (3) Master the gene mutation and its biological effects
- (4) Know the human genomics and genome research
- (5) Know genomics and human health

2. COURSE CONTENT

- (1) The composition of the human genome and genetic regularity
- (2) The gene and gene expression regulation
- (3) The gene mutation and its biological effects
- (4) The human genomics
- (5) Genome research
- (6) Genomics and human health

3. TEACHING HOURS

4 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 3 Chromosomal Diseases

1. OBJECTIVES

- (1) Master the basic characteristics of human chromosomes
- (2) Master the research method of human chromosomes
- (3) Master the karyotype and pathogenesis of common chromosomal diseases
- (4) Know the mechanism of chromosomal aberration

2. COURSE CONTENT

- (1) The basic characteristics of human chromosomes
 - ① Chromatin and chromosome
 - ② The number, structure and shape of human chromosomes

③ Sex chromosome and gender determination

④ Research method of chromosome

(2) Chromosome aberration

① Chromosome number aberration

② Chromosome structure aberration

③ The cause of chromosome aberration

(3) Chromosomal diseases

① Autosomal diseases

② Sex chromosome diseases

3. TEACHING HOURS

6 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 4 Monogenic Inherited Diseases

1. OBJECTIVES

(1) Know classification, mode of inheritance and the major genetic mating type of monogenic inheritance diseases

(2) Master genetic characteristics of all genetic ways of monogenic inheritance diseases

(3) Master the pedigree analysis method of monogenic inheritance diseases

2. COURSE CONTENT

(1) Classification of monogenic inheritance diseases

① Autosomal dominant inheritance: concept, common mating types, genetic characteristics and subtype of autosomal dominant genetic diseases

② Autosomal recessive inheritance: concept, common mating types and genetic characteristics of autosomal recessive genetic diseases

③ Sex-linked inheritance

(a) X-linked inheritance: the unique features of X-linked inheritance

(b) Y-linked dominant inheritance: concept and genetic characteristics of Y-linked genetic diseases

(2) Non-classical Mendelian heredity: the concept of expressivity and penetrance, genetic heterogeneity, pleiotropy, phenocopy, sex-conditioned inheritance, sex-limited inheritance, genetic imprinting and so on.

(3) Mitochondrial Diseases: structural features of mtDNA; genetic characterization of mtDNA; mitochondrial DNA mutation and mitochondrial diseases

3. TEACHING HOURS

5 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 5 Human Biochemical Inherited Diseases

1. OBJECTIVES

(1) Master the characteristics of hemoglobinopathy and thalassemia

(2) Master the pathogenesis of common enzymopathy

(3) Know familial hypercholesterolemia and Wilson disease

2. COURSE CONTENT

(1) Hemoglobinopathy and thalassemia

① Molecular structure and genetic control of hemoglobin

② Hemoglobin variant and hemoglobinopathy

③ Thalassemia

(2) Plasma protein disease: hemophilia

(3) Enzymopathy

① Aminoacidopathy

② Saccharine disease

(4) Receptor protein diseases: familial hypercholesterolemia

(5) Membrane transport carrier protein diseases: Wilson disease

3. TEACHING HOURS

3 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 6 Polygenic Inheritance

1. OBJECTIVES

- (1) Master the characteristics of polygenic inheritance
- (2) Master the concept of Liability, susceptibility, and heritability
- (3) Master the estimation of recurrence risks of polygenic inheritance diseases
- (4) Know the calculation of heritability
- (5) Know how to find genes for polygenic disorders
- (6) Know the genetics of several polygenic diseases

2. COURSE CONTENT

- (1) Polygenic inheritance
 - ① Quantitative trait and qualitative trait
 - ② The polygenic inheritance of quantitative trait
- (2) Inheritance of polygenic diseases
 - ① Liability, susceptibility, and threshold
 - ② Heritability
 - ③ Finding genes for polygenic diseases
- (3) Influence factors on estimation of recurrence risk of polygenic inheritance diseases
 - ① Degree of relative
 - ② Severeness of the disease
 - ③ Number of affected individuals in the family
 - ④ Gender
- (4) Genetics of several common polygenic diseases
 - ① Schizophrenia
 - ② Diabetes
 - ③ Asthma

3. TEACHING HOURS

3 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 7 Population Genetics

1. OBJECTIVES

- (1) Master the concept of allele and genotype frequencies
- (2) Master Hardy-Weinberg equilibrium and its applications
- (3) Master the concept and the risk of consanguineous marriage
- (4) Know the influence factors on genetic equilibrium
- (5) Know the calculation of inbreeding coefficients
- (6) Know linkage disequilibrium and association study

2. COURSE CONTENT

- (1) Population genetic equilibrium: allele frequency and genotype frequency
- (2) The law of genetic equilibrium(Hardy-Weinberg equilibrium law)
- (3) The influence factors on population gene frequency
 - ① Mutation on population genetic equilibrium
 - ② Selection on population genetic equilibrium
 - ③ Genetic drift and migration
- (4) Consanguineous marriage
 - ① Autosomal inbreeding coefficient
 - ② X-linked gene inbreeding coefficient
- (5) Polymorphisms, linkage disequilibrium, and association study
 - ① Polymorphic markers in human genome
 - ② Linkage disequilibrium
 - ③ Association studies

3. TEACHING HOURS

3 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 8 Cancer Genetics

1. OBJECTIVES

- (1) Master the concept of oncogene, proto-oncogenes and tumor suppressor gene
- (2) Master the occurrence of tumor and chromosome abnormality
- (3) Know the “two-hits” hypothesis
- (4) Know the phenomenon of family accumulation, the hereditary malignant tumor and hereditary precancerous lesions
- (5) Know the genetic theories and mechanism of cancer

2. COURSE CONTENT

- (1) The genetic factors in the occurrence of tumor
 - ① The family accumulation of tumor: cancer family and familial carcinoma
 - ② Inherited tumors
- (2) Carcinoma and chromosome abnormality
 - ① The number abnormalities of tumor chromosome
 - ② The structural aberrations of tumor chromosome, marker chromosomes
- (3) Carcinoma hypothesis relating to hereditary tumor: tumor monoclonal origin hypothesis, “two-hits” hypothesis; multi-step theory
- (4) The genetic mechanism of tumor
 - ① Oncogene: concept; type; oncogene activation
 - ② Tumor suppressor gene: concept, types, functions; *Rb* gene, *P53* gene, *DCC* gene, etc.
 - ③ Somatic mutations

3. TEACHING HOURS

3 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Chapter 9 Clinical Genetics

1. OBJECTIVES

- (1) Master methods and applications of prenatal diagnosis

- (2) Know the diagnostic methods of genetic diseases
- (3) Know the basic principles of conventional treatment of genetic diseases and Gene therapy
- (4) Know the prevention of inherited diseases and genetic counseling

2. COURSE CONTENT

(1) The type and means of genetic diseases diagnosis

- ① Cytogenetic test: karyotype analysis, FISH
- ② Biochemical test
- ③ Gene diagnosis and gene sequencing
- ④ Prenatal diagnosis: methods and applications

(2) The treatment of genetic diseases

- ① The basic principles of conventional therapy
- ② Gene therapy

(3) The prevention of genetic diseases

- ① Genetic screening: Preimplantation genetic test, prenatal screening; neonatal screening; carrier detection
- ② Genetic counseling: Objects and steps; type; process (focus: the recurrence risk estimation of genetic diseases; the application of Bayes theory)

3. TEACHING HOURS

4 class hours

4. TEACHING METHOD

Small class teaching. Lecture with multimedia computer assisted instruction

Self-Directed Learning

1. CONTENTS

Analyze 1 to 2 kinds of genetic diseases based on the available genetic knowledge.

2. PURPOSES

(1) Establish the thinking platform of Genetics and understand the important roles of genetic knowledge and regularity in disease occurrence, development, diagnosis, therapy and prevention.

(2) Flexibly master the genetic regularity and apply it in practice, and improve the ability of genetic disorder analysis and genetic counseling.

3. FORMS

A natural class including 30 students will be as a unit directed by one teacher.

(1) The theory class teacher should arrange the learning content in the first class of the course.

(2) Students finish the summary reports after consulting the books and references (no less than 5 papers in the last 3 years).

(3) Divide the students into 5 groups on ID and discuss for 1 hour.

(4) Representatives of each group report for 1 hour.

4. SCHEDULES

2 class hours

5. REQUIREMENTS

Each student should write a report around 1 to 2 genetic diseases according to the searched references and make comprehensive analysis and discussion about the pathogenic mechanism, diagnosis, therapy, prognosis and prevention.

6. ASSESSMENTS

The performance of independent study will occupy a certain proportion in the final examination.

《医学遗传学》教学大纲(实验)

(授课对象：基础医学(朱宪彝班) 专业)

Preface

Experiment teaching is an important part of the course of genetics. However, there is no nationwide unified teaching material so far. In order to guarantee the quality of the experimental teaching, we compile this syllabus on the basis of the experimental teaching experience accumulated for many years. The syllabus contains the requirements of basic theoretical knowledge and experimental technology for each experiment, which will help the students to master the basic theory and techniques systematically, and lay a solid foundation for continuous classes, and provide the basis for class preparation, assessments of teaching level and examinations as well.

The teaching contents in this syllabus are arranged for students of basic medicine. The class hours are 54 in total (18 for laboratory).

Experiment 1 Preparation and Observation of Meiosis Specimens of Mouse Spermatocyte

1. OBJECTIVES

- (1) Know the importance of meiosis in sexual reproduction
- (2) Master the basic techniques in preparation of meiosis specimens of mouse spermatocyte
- (3) Know the characters of each period in the process of meiosis, master the method of identifying each meiotic phase under light microscope

2. COURSE CONTENTS

- (1) Prepare meiosis specimens of mouse spermatocyte
- (2) Observe and count the cells in meiosis under light microscope

3. TEACHING HOURS

4 class hours

4. TEACHING METHOD

Teacher demonstration method, students operation method

Experiment 2 Preparation and Observation of Micronucleus Specimens of Mouse Bone Marrow Polychromatic Erythrocyte

1. OBJECTIVES

- (1) Know the mechanism of micronucleus formation and the importance of micronucleus experiments
- (2) Master the preparation method of micronucleus specimen
- (3) Get familiar with the statistical approach of micronucleus

2. COURSE CONTENTS

- (1) Prepare micronucleus specimen of mouse bone marrow polychromatic erythrocyte
- (2) Observe and count the micronucleus of mouse bone marrow polychromatic erythrocyte

3. TEACHING HOURS

4 class hours

4. TEACHING METHOD

Teacher demonstration method, students operation method

Experiment 3 Preparation and Observation of Human Peripheral Blood Lymphocyte Chromosome Specimens

1. OBJECTIVES

- (1) Initially master the short term culturing method of human peripheral blood lymphocytes
- (2) Master the preparing method of human peripheral blood lymphocyte chromosome specimens

2. COURSE CONTENTS

- (1) Culture of human peripheral blood lymphocytes
- (2) Prepare human peripheral blood lymphocyte chromosome specimens
- (3) Observe human peripheral blood lymphocyte chromosome specimens

3. TEACHING HOURS

6 class hours

4. TEACHING METHOD

Teacher demonstration method, students operation method

Experiment 4 Karyotype Analysis of Human Chromosomes

1. OBJECTIVES

- (1) Know the morphology and the number of chromosomes in normal human cells
- (2) Distinguish each group of human chromosomes under light microscope
- (3) Master the method of karyotype analysis
- (4) Know the measuring method of chromosomes

2. COURSE CONTENTS

- (1) Observe and count the human chromosome specimens
- (2) Karyotype analysis of normal human chromosome —cutting and pasting

3. TEACHING HOURS

2 class hours

4. TEACHING METHOD

Teacher demonstration method, students operation method

Experiment 5 Preparation and Observation of Human G-banding Chromosome Specimens

1. OBJECTIVES

- (1) Master the preparing method of C-banding chromosome specimens
- (2) Know the analysis and identification standards of chromosome G-banding pattern

2. COURSE CONTENTS

- (1) Prepare the G-banding chromosome specimens
- (2) Observe the G-banding chromosome specimens

3. TEACHING HOURS

1 class hours

4. TEACHING METHOD

Teacher demonstration method, students operation method

Experiment 6 Observation and Analysis of Human Monogenetic Inheritance

1. OBJECTIVES

- (1) Know genetic traits and made of inheritance of human monogenic inheritance
- (2) Mater the survey and analysis methods of human monogenic inheritance

2. COURSE CONTENTS

- (1) Observe genetic traits of head, eye, ear, nose, tougue, hand and other body parts
- (2) Analyze the ratio of dominant to recessive

3. TEACHING HOURS

1 class hour

4. TEACHING METHOD

Teacher demonstration method, students operation method