

# SYLLABUS

---

INTERNATIONAL EUROPEAN  
UNIVERSITY



SCHOOL OF  
MEDICINE

MEDICAL AND BIOLOGICAL PHYSICS.  
MEDICAL INFORMATICS

2023



# SYLLABUS




Discipline 

 Medical and Biological Physics. Medical Informatics.

Teacher(s) 


 Associate Professor of the Department of Fundamental Disciplines, Zoya Sherman; Senior Lecturer Taraniuk Gennadiy Petrovich

Profile of the teacher(s) 


 <https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin>

Consultations


Face-to-face consultations

 Fourth Tuesday of the month 15:00-16:00


Online consultations

 Second Friday of the month 15:00- 16:00


Contact phone number 

 +38 050 181 13 30 (Sherman Zoya Alexandrovna)  
+38 099 707 71 09 (Taraniuk Gennadiy Petrovich)

E-mail 

 zoiasherman@ieu.edu.ua (Sherman Zoya Alexandrovna)  
gennadiytaranyuk@ieu.edu.ua (Taraniuk Gennadiy Petrovich)

Discipline page 

 <https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin>

Form of final control

Passe	Differentiated credit	Exam
-------	-----------------------	------



# SYLLABUS



## 1 Brief annotation of the discipline

"Medical and Biological Physics. Medical Informatics" is a fundamental medical and biological discipline that studies objects of living nature and the human body in particular, based on physical phenomena and processes that determine their vital activity and underlie diagnostic, therapeutic and preventive methods of medicine. The discipline consists of five main content modules, the first three are: Fundamentals of Mathematical Processing of Medical and Biological Data and Fundamentals of Biological Physics; Fundamentals of Medical Physics; Fundamentals of Medical Optics and Radiation Diagnostics. The fourth and fifth content modules consist of: the basics of information technology in the field of health care; processing and analysis of medical and biological data; medical data. Methodology of processing and analysis of medical information. "Medical informatics" is an applied, practical science that studies the patterns and methods of obtaining, storing, processing and using knowledge in medical science and practice in order to expand the possibilities of cognition.

## 2 Prerequisite for studying the discipline

The study of the discipline "Medical and Biological Physics. Medical Informatics" is based on the previously acquired knowledge of physics, mathematics, chemistry and biology in accordance with the secondary school curriculum.

## 3 Purpose and objectives of the discipline

The purpose of studying module 1 of the discipline "Medical and Biological Physics. Medical Informatics" is to form in students an integral complex of general scientific, fundamental physical and biophysical knowledge necessary for understanding medical and biological phenomena and acquiring relevant professional competencies in the field of practical medicine. The purpose of studying module 2 is to form theoretical knowledge, practical skills and abilities to work with a personal computer and various application programs that are necessary for the effective use of modern software and hardware computerization in the educational process, scientific and professional activities, familiarization with the latest information technologies and the possibilities of their application in professional activities, which allows to optimize information processes.

The main objectives of the discipline "Medical and Biological Physics. Medical Informatics" are:

- mastering the methods of mathematical modeling and statistical processing of medical and biological information.
- study of the biophysical basis of the functioning of systems and organs of the human body in normal and pathological conditions;
- study of the mechanisms of influence of physical environmental factors on the human body at the micro and macro levels of the organization of life;
- studying the physical and technical bases of diagnostic, therapeutic and preventive methods of medicine, the operation of medical equipment;
- mastering knowledge of the essence of information and medical information, informatics and information processes in medicine;
- formation of the ability and skills to solve typical and complex specialized problems, practical problems in professional activities in the field of health care related to the use of a personal computer and work with general-purpose programs;
- mastering the system of knowledge and skills for conducting research and/or implementing innovations in medicine using modern approaches characterized by complexity and insignificance of requirements using



# SYLLABUS



calculation and analytical methods;

- mastering knowledge of modern information technologies in general and their use in medicine.

## 4 Learning Outcomes

<b>PLO 1</b>	Have a thorough knowledge of the structure of professional activity. Be able to carry out professional activities that require updating and integration of knowledge. Be responsible for professional development, the ability to further professional training with a high level of autonomy
<b>PLO 2</b>	Understanding and knowledge of basic and clinical biomedical sciences, at a level sufficient to solve professional problems in the field of health care
<b>PLO 21</b>	Find the necessary information in professional literature and databases and other sources, analyze, evaluate and apply this information
<b>PLO 22</b>	Apply modern digital technologies, specialized software, statistical methods of data analysis to solve complex health care problems.

## 5 ECTS Credits

5 ECTS credits / 150 academic hours, of which 64 are practical classes, 70 are independent work.

## 6 Structure of the discipline

Topic Name	Number of hours full-time		
	l.	p.	i.
Module 1. "Medical and Biological Physics"			
Content module 1. Mathematical Foundations of Biomedical Data and Fundamentals of Biological Physics.			
Topic 1. Fundamentals of Probability Theory and Mathematical Statistics.	2	4	3
Topic 2. Fundamentals of Biorheology. Fundamentals of Bioacoustics. Biophysics of hearing. Physical Bases of Ultrasound Diagnostics.	2	4	3
Topic 3. Physical Foundations of Hemodynamics.	1	3	3
Topic 4. Biophysics of membrane processes. Membrane potentials. Action potential.	1	3	3
Topic 5. Control work on the content module 1 "Fundamentals of statistical analysis of medical and biological data and fundamentals of biological physics".		2	
Total for Content Module 1	6	16	12



# SYLLABUS



## 6 Structure of the discipline

Topic Name	Number of hours full-time		
	l.	p.	i.
<b>Content module 2. Fundamentals of Medical Physics</b>			
Topic 6. Electrographic diagnostic methods.	2	2	3
Topic 7. Study of the frequency dependence of impedance of biological tissues and its application in medical research.	2	2	3
Topic 8. Physical Foundations and Methods of Physiotherapy.	2	2	3
Topic 9. Control work on the content module 2 "Fundamentals of Medical Physics".		2	
<b>Total for Content Module 2</b>	<b>6</b>	<b>8</b>	<b>9</b>
<b>Content module 3. Fundamentals of Medical Optics and Radiation Diagnostics.</b>			
Topic 10. Fundamentals of Biological Optics. Optical Methods of Biological Object Research.	1	3	3
Topic 11. Physical Foundations of Radiology and Radiation Medicine. Radiation safety.	1	3	3
Topic 12. Fundamentals of radiation diagnostics. X-ray computed tomography, magnetic resonance imaging, positron emission tomography and other types.	2	2	
Topic 13. Final control of module 1.		2	
<b>Total for Content Module 3</b>	<b>4</b>	<b>10</b>	
<b>Total hours to study Module 1 "Medical and Biological Physics"</b>	<b>16</b>	<b>34</b>	<b>9</b>
<b>Module 2. "Medical Informatics"</b>			
<b>Content module 4. Fundamentals of Information Technology in the Field of Health Care.</b>			
Topic 1. Basic concepts of the discipline "Medical Informatics"		2	2
Topic 2. Coding and classification of medical data.		2	2
Topic 3. Analysis of biosignals. Visualization of biomedical data.		2	3
Topic 4. Medical Image Processing and Analysis.		2	3
Topic 5. Fundamentals of Statistical Analysis of Medical and Biological		2	3

Topic Name	Number of hours full-time		
	l.	p.	i.
Topic 6. Testing statistical hypotheses. Correlation analysis.		2	3
Topic 7. Fundamentals of Telemedicine.		2	3
Topic 8. Application of telecommunication technologies in medicine. "Telemedicine Network of the Regional Center".		2	3
<b>Total for Content Module 4</b>		<b>16</b>	<b>22</b>
Table of contents section 5. Methodology of Processing and Analysis of Medical Information.			
Topic 9. Network diagnostic systems.		2	3
Topic 10. Formal logic in solving the problems of diagnosis, treatment and prevention of diseases.		2	3
Topic 11. Decision support methods. Strategies for obtaining medical knowledge.		2	3
Topic 12. Forecasting tools. Clinical Decision Support Systems.		2	3
Topic 13. Simulation of the decision support system.		2	3
Topic 14. Types of Health Information Systems.		2	3
Topic 15. Final control of module 2.		2	
<b>Total for Content Module 5</b>		<b>14</b>	<b>18</b>
<b>Total Hours for Module 2 "Medical Informatics"</b>		<b>30</b>	
Topic 4. Just an hour and analysis of medical images.	16	64	70

**Module 1: Medical and biological physics**

1. Application of methods of probability theory and statistical analysis of biomedical data.
2. Surface tension and its biological significance.
3. Modeling and calculation of membrane potentials.
4. Modeling of elastic properties of biological tissues.
5. Modeling and calculation of hemodynamic parameters.
6. Determination of fluid viscosity.
7. Determination of blood viscosity in the clinic.
8. Calculation of hemodynamic parameters according to rheograms.
9. Modeling the impedance of biological tissues.



# SYLLABUS



10. Cardiogram data processing.
11. Determination of the threshold of audibility by the audiometric method.
12. Determination of physical effects of physiotherapeutic methods.
13. Determination of the properties of biological fluids based on optical research methods.
14. Biological effects of ionizing radiation.

## Module 2: "Medical informatics"

1. Completion of the task (calculation work)
2. Performing the task (building a graphical representation of data). Data and information.
3. Rules for building presentations using standard software packages. Design and printing of documents.
3. Working with textual information. Use of the text editor Word. Design and printing of documents.
4. Working with medical data models. Performing practical tasks.
4. Performing tasks using WHO, MOH databases and the Ukrainian Medical and Statistical Information Base "Health for All".
5. Performing a task using a protein database - PDB database
6. Performing a task on biosignal analysis. Registration, transformation and classification of signals.
7. Performing the task of analyzing the errors of MRI and ultrasound images. Medical image processing. Modern trends in image processing.
8. Construction of algorithms for solving medical problems using different types of algorithms.
9. Drawing up a block diagram of a simple (linear) and branched algorithm. Drawing up a block diagram of an algorithm with an internal loop.
10. Building a truth table using logical operators.
11. Using a test decision support system.
12. Using a decision support system with simple forecasting tools to solve test problems.
13. Familiarity with medical literature databases and methods of their analysis.
14. Work with traditional and electronic medical records (electronic medical history).
14. Use of information resources in evidence-based medicine - comparative analysis of information resources.
15. Performing a task on biomolecules using VMD and NAMD software packages
16. Performing a task on the analysis of impact factors of medical journals and publications
17. Performing the task of analyzing the possibilities of using chemicals in medicine using QSAR methodology
18. Performing the task of analyzing the structure of albumin
19. Performing a task on the classification of drugs based on WHO databases.
20. Performing the task of classifying diseases based on WHO databases

## Module 1: Medical and biological physics

1. Creation of multimedia presentations on the topics of practical classes of indirect measurement errors.
2. Calculation of mean arterial pressure.
3. Bayes' theorem and its clinical application.
4. The normal law of distribution of a random variable.
5. Calculation and calculation of thermodynamic potentials.
6. Neurotransmission.
7. Biophysical models of muscle contraction.
8. Biophysics of the heart muscle.
9. Modeling of geodynamic processes.
10. Ultrasound diagnostic methods.
11. Blood viscosity: methods of measurement and clinical significance.
12. Rheography and its clinical significance.
13. Electrophysiology of organs and tissues of the body.
14. Magnetocardiography.



# SYLLABUS



15. Eye as an optical system. Biophysics of vision.
16. Methods of radiography.
17. Magnetic resonance imaging.
18. Calculation of radiation safety parameters.

## Module 2: "Medical informatics"

1. Computer programs-applications in the health care system.
2. Internet. Communication in the health care system.
3. Means of obtaining images.
4. Statistical methods in medical informatics.
5. Model of population epidemic dynamics
6. Mathematical models in the processing and transformation of biosignals, MRI and ultrasound data.
7. Methods of statistical processing and error theory when working with medical data
8. Normal law of distribution of a random variable.

9

## Signs of discipline

Term of Teaching	Semester	International disciplinary integration	Course (year of study)	Cycles: general training/ vocational training/ free choice
1semester	1semester	Yes	1st	General training

10

## Grading System and Requirements

General assessment system of the discipline:

The current performance of students is evaluated on a 4-point scale (2; 3; 4; 5) at each practical (seminar, laboratory) lesson.

The final control of knowledge in the discipline "Medical and Biological Physics" is carried out in the form of a differentiated test. The differentiated test in the discipline is conducted in the form of a written test for individual options, each of which contains 3 theoretical questions and one task.

### Requirements for written work:

The tasks of practical classes must be drawn up in writing and submitted to the teacher for verification for the purpose of their evaluation.

Загальна система оцінювання дисципліни :

11

## Conditions of admission to the final control

A condition for student admission to the final control is the absence of missed or unexecuted practical classes, as well as an average current grade of at least 3 points on a 4-point scale / 120 points on a 200-point scale.

<https://ieu.edu.ua/docs/rate-of-study.pdf>

12

## Discipline Policy

The study of the discipline "Medical and Biological Physics. Medical Informatics" involves compliance with the rules that ensure effective mastery of the subject

rules that ensure effective mastery of the subject, both in theory and in practice, namely

- regular attendance at lectures and practical classes without absences





# SYLLABUS



- the presence of the teacher and students in the classroom in accordance with the schedule and the established time regulations of classes
- the presence of the teacher and students in the classroom neatly dressed in appropriate clothing, namely in a white coat
- full presentation of the course by the teacher in accordance with the program of the discipline
- student's keeping lecture notes and notes on practical classes
- the study of the discipline is based on collegiality, cooperation and solidarity of the teacher and students
- discussion of educational issues takes place in the form of a discussion between the teacher and students, and students among themselves
- lectures and practical classes, except for the final control of knowledge, involve independent work of students using information technology and means of processing, storing and transmitting information, including computers, personal gadgets and other electronic devices, as well as textbooks, manuals, methodological developments, etc.
- scientific search and research work of students is welcome
- Writing essays on the topics specified in the list of compulsory assignments is a part of the training
- writing essays on the list of topics of optional assignments is desirable and mandatory if a student wants to improve his or her grade
- the topics of the discipline are considered in terms of their practical application and bioethical capacity
- the mutual behavior of the teacher and students, and students among themselves in the classroom and out of class and out-of-class time complies with generally accepted norms and role models of behavior that provide for mutual respect and collegiality of relationships, and exclude religious, racial, ethnic, cultural, age, gender, social, political, and other prejudices and prejudices, as well as bullying, sexual harassment, and other manifestations and forms of intolerance and humiliation of human dignity
- any manifestations of corruption in the educational process, both on the part of the teacher and students, are unacceptable.

## Policy for missing classes and completing assignments after the deadline

13

A student who, for valid reasons, confirmed by documentary evidence, was not subject to current control has the right to undergo current control within two weeks after returning to study.

A student who was absent from classes without valid reasons, did not participate in current control activities, did not eliminate academic debt, is not allowed to take the final semester control of knowledge in this discipline, and on the day of the exam, the academic staff member assigns a grade of "not admitted" in the exam report.

Retaking the differentiated test in the discipline is assigned subject to the completion of all types of educational, independent (individual) work provided for by the working curriculum of the discipline and is carried out in accordance with the schedule of liquidation of academic debt approved by the directorate.

<https://ie.u.edu.ua/docs/050.pdf>

## Academic Integrity Policy

14

Participants in the educational process are guided by the principles of academic integrity

<https://ie.u.edu.ua/docs/011.pdf>

## Recommended sources of information

15

Basic literature:

Module 1: "Medical and biological physics"

1. Medical and biological physics. National textbook for students of medical. National textbook for students of medical universities of III - IV levels of accreditation / [Chaly O.V. (ed.), Tsekhmister Y.V.,



# SYLLABUS



15

## Recommended sources of information

- Agapov B.T. and others]: Vinnytsia, Nova Knyha, 2020. - 526 p.
2. Medical and biological physics: a textbook for students of higher education institutions / [S.V. Pogorelov, E.O. Romodanova, R.R. Osmanov, V.O. Timanyuk] National University of Pharmacy - Kharkiv: NUPh: Golden Sides, 2019. - 263 c.
  3. Medical and biological physics. Part I / [V.I. Fediv, O.I. Olar, O.Y. Mykytyuk et al. A textbook for students of higher medical schools - Chernivtsi: BSMU Publishing House, 2016. - 205 p. (Recommended by the State Institution "Central Methodological Cabinet for Higher Medical Education of the Ministry of Health of Ukraine", letter No. 23-01-9/225 of 05.03.2016, protocol No. 1 of 24.03.2016).
  4. Medical and biological physics. Part II / [V.I.Fediv, O.I.Olar, O.Y.Mykytyuk, V.F.Boyechko]. Study guide for students of higher medical schools - Chernivtsi: BSMU Publishing House, 2017. - 235 p. (recommended by the State Institution "Central Methodological Cabinet for Higher Medical Education of the Ministry of Health of Ukraine", letter No. 23-01-9/261 of 08.06.2017, protocol No. 2 of 02.06.2017)
  5. Medical and biological physics. Study guide for students of higher medical educational institutions / V.I. Fediv, O.I. Olar, V.V. Kulchynsky, G.Y. Rudko. Study guide for students of higher medical schools - Chernivtsi, Bukovinian State Medical University, 2017. 342 p. - Language: English (recommended by the State Institution "Central Methodological Cabinet for Higher Medical Education of the Ministry of Health of Ukraine", letter № 23-01-9/258 of 08.06.2017, protocol № 2 of 02.06.2017).
  6. Medical and Biological Physics. MODULE 1. Mathematical processing of medical and biological data. Basic of regularities of biomechanics and electricity and their use for diagnosis and treatment. Educational-methodical textbook / ed. by V.I. Fediv // Chernivtsi, Higher State Educational Establishment of Ukraine "Bukovinian State Medical University", 2019. - 146 pp.
  7. Medical and Biological Physics. MODULE 2. Basic concepts and laws of electromagnetism, optics, quantum and nuclear physics. Educational-methodical textbook / ed. by V.I. Fediv // Chernivtsi, Bukovinian State Medical University, 2020. - 151pp.
  8. Zima V.L. Biophysics. Collection of tasks. K.: Higher School, 2001.
  9. Lopushansky J. Biophysics. Collection of problems and questions in medical and biological physics. Lviv, Taras Shevchenko Scientific Society, 2006.

### **Additional literature:**

1. Medical and biological physics: a textbook for students of higher medical (pharmaceutical) educational institutions / edited by Prof. O. V. Chaly - 2nd ed: Nova Knyha, 2017. - 528 p.
2. Medical and Biological Physics. / edited by prof. A.V. Chalyi. - 2nd ed. - Vinnytsia, Nova Knyha, 2013. - 480 p.
3. Biophysics / P.G. Kostyuk (ed.), V.L. Zima, I.S. Magura, M.S. Miroshnychenko, M.F. Shuba - Kyiv: VPC "Kyiv University", 2008.
4. Structure and principles of medical equipment: manual / V.D. Didukh and others - TSMU. - 2016. - 268 c.

### **Additional information resources:**

1. Ministry of Education and Science of Ukraine <http://www.mon.gov.ua/>
2. Vernadsky National Library of Ukraine <http://www.nbuv.gov.ua/>
3. Internet resources for higher mathematics, medical and biological physics. Module 2: "Medical Informatics"

### **Basic literature:**

1. Medical informatics : a workshop for medical students / S. Pudova, T. Vuzh, T. Revina ; Vinnytsia National Medical University named after M. Pirogov. - Vinnytsia: Nilan Ltd, 2021. - 103 c.
2. Medical informatics: a textbook / O. V. Silkova, N. V. Lobach ; Higher State Educational Institution of Ukraine "Ukrainian Medical University". Higher State Educational Institution of Ukraine "Ukrainian Medical and Dental Academy". - Edition 2, amended, revised - Poltava: ASMI, 2016. - 262 c.
3. Medical informatics in modules: a workshop / I.E. Bulakh, L.P. Voitenko, M.R. Mruga et al. -K.: Medicine, 2012. - 208 p.
4. Handbook of Medical Informatics. Editors: J.H. van Bommel,



# SYLLABUS



15

## Recommended sources of information

M.A. Musen. - <http://www.mieur.nl/mihandbook>; <http://www.mihandbook.stanford.edu>

5. Mark A. Musen B. Handbook of Medical Informatics // Electronic resource  
<ftp://46.101.84.92/pdf12/handbook-of-medical-informatics.pdf>

6. Edward H., Shortliffe J., Cimino J. Biomedical Informatics, 2014 // Electronic resource  
<http://www.rhc.ac.ir/Files/Download/pdf/nursingbooks/Biomedical%20Informatics%20Computer%20Applications%20in%20Health%20Care%20and%20Biomedicine-2014%20-%20CD.pdf>

7. Medical Informatics: Computer Applications in Health Care and Biomedicine, 2011 // <https://books.google.com.ua/books?id=WYvaBwAAQBAJ&pg=PA321&lpg=PA321&dq=book++medical+informatics&source=bl&ots=VjPvStLtIk&sig=b39YVoBlts31QSJkUf4bnAjTqfY&hl=uk&sa=X&ved=0ahUKEwiqkeTdpIzQAhUGWSwKHTyIBfw4ChDoAQhHMAc#v=onepage&q=book%20%20medical%20informatics&f=false>

### Supporting literature:

1. Informatics in tables and diagrams: PC and its components, Windows operating system, Internet, main and auxiliary devices, system and application software, modeling and programming / [Bilousova L.I., Olefirenko N.V.] - Kharkiv: Torsing Plus, 2014. 111 p.

2. Lopoch S.N., Chubenko A.V., Babych P.N. Statistical methods in medical and biological research using EXCEL. - K.: Morion, 2001. - 408 p.

3. Information systems and technologies: Study guide for students of higher educational institutions / S.G. Karpenko, V.V. Pozov, Y.A. Tarnavsky, G.A. Shportyuk - K.: IAPM, 2004. - 192 p.

4. Paul J. Perry. Secrets of the World Wide Web. Kyiv. 1996. 576c.

5. Medical informatics: textbook / I.E. Bulakh, Y.E. Lyakh, V.P. Martsenyuk, I.I. Khaimzon. - K.: VSI "Medicine", 2012. - 424 p.

6. Medical Informatics = Medical Informatics: Textbook / I.E. Bulakh, Y.E. Lyakh, V.P. Martsenyuk, I.I. Khaimzon - K.: VSI "Medicine", 2012. - 368 p.

7. Information technologies in psychology and medicine: textbook / I.E. Bulakh, I.I. Khaimzon - K.: VSI "Medicine", 2011. 216 p.

8. Informatics in tables and diagrams: PC and its components, Windows operating system, Internet, main and auxiliary devices, system and application software, modeling and programming / [Bilousova L.I., Olefirenko N.V.] - Kharkiv: Torsing Plus, 2014. 111 p.

9. Fundamentals of computer science. Microsoft Office 2013 (Word, PowerPoint in practice): a textbook / M. Drin, N. Romanenko; Ministry of Education and Science of Ukraine, Yuriy Fedkovych Chernivtsi National University - Chernivtsi: Chernivtsi National University, 2014. 75 p.

10. Informatics and information technologies: a workshop for the organization of students' work in practical and laboratory classes / Y. Bilak, V. Laver, Y. Andrashko, I. Lyakh; Ministry of Education and Science of Ukraine, Uzhhorod National University, Faculty of Information Technologies, Department of Informatics and Physical and Mathematical Disciplines.

- Uzhhorod: Outdoorshark, 2015.

11. Informatics: a workshop on information technologies / Y. M. Hlynskyi - Ternopil: Pidruch. i pobed. 2014. - 302 p.

12. Mintzer O.P. Informatics and health care / O.P. Mintzer // Medical Informatics and Engineering. - 2010. - No. 2. - P.8 -21

13. Computer modeling in pharmacy: Study guide for medical schools. Recommended by the Ministry of Health of Ukraine / Bulakh I.E. et al.

### Information resources

1. <https://support.office.com/uk-ua/> (Reference and training materials of the Microsoft Office package)

2. [www.uacm.kharkov.ua](http://www.uacm.kharkov.ua) (Ukrainian Association "Computer Medicine")

3. [www.mednavigator.net](http://www.mednavigator.net) (Medical search engine)

4. [www.medinfo.com.ua](http://www.medinfo.com.ua) (Medical Search Engine of Ukraine)

5. [www.medinf.nmu.ua](http://www.medinf.nmu.ua) (Information resources of educational and methodological materials in the



# SYLLABUS



discipline

"European Standard of Computer Literacy").

16

## Tips for successful studying on the course

Attendance of classes

Dialogue with the teacher on all issues of the curriculum Completion of assignments in accordance with the program

Writing essays on the topics of the program

Discussion of topics and assignments in groups outside of class time Use of Internet resources