N P L E X®

Naturopathic Physicians Licensing Examinations

Part I - Biomedical Science Examination: Blueprint and Study Guide

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Applicable to February 2027 NPLEX Exam Administrations

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This *Blueprint and Study Guide* is intended to provide general information to anyone who will be taking the NPLEX Part I - Biomedical Science Examination. The NPLEX Board reserves the right to make revisions as necessary. Examinees should consult the latest edition of the *Blueprint and Study Guide* for the most up-to-date information regarding the content of the exam.

The North American Board of Naturopathic Examiners (NABNE) sets and implements the policies that govern the administration of the NPLEX. Examinees should consult the latest edition of the *NABNE Examinee Handbook* at https://nabne.org/nabne-forms/ for up-to-date information regarding these policies.

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INTRODUCTION

NPLEX, Inc., is an independent, nonprofit organization whose purpose is to prepare valid and reliable board-level licensing examinations for the naturopathic medical profession in the U.S., U.S. Territories, and Canada. Agencies that regulate the practice of naturopathic medicine may use NPLEX results in determining a candidate's eligibility for licensure/registration.

The North American Board of Naturopathic Examiners (NABNE) is responsible for the administration of the NPLEX exams. NABNE verifies applicant eligibility to sit for the NPLEX, administers the NPLEX, and reports NPLEX exam results to the examinees and to regulatory agencies if requested by the examinee.

The Part I - Biomedical Science Examination (BSE) is designed to measure a student's readiness to engage in the clinical phase of training. The purpose of the BSE is to ensure that the student has acquired the foundation in biomedical sciences that is essential to clinical training, as well as for practice as a naturopathic medical doctor.

The Part II - Clinical Science Examination (CCSE) is designed to measure a graduate's readiness to practice naturopathic medicine. The purpose of the CCSE is to ensure that graduates have acquired broad foundational knowledge to practice as minimally competent naturopathic medical doctors. Minimal competence is the term used for professional licensing exams, to gauge the knowledge, skill, and ability necessary to safely practice as a licensed/registered naturopathic medical doctor.

The Part II - Elective Examinations assess minimal competence in additional areas that may not be addressed in the CCSE.

The NPLEX exams are competency based. A competency-based exam is an assessment designed to evaluate ability to perform specific skills or tasks in a profession, focusing on a practical application of knowledge rather than just memorization. The exam utilizes clinical scenarios as a framework for demonstrating proficiency in naturopathic medical principles and application.

NPLEX is committed to creating exams that are free from bias. While we recognize the impact of individual identities (including, but not limited to, genetic ancestry, gender identity, sexuality, ability, socioeconomic status, and cultural heritage) on health, every effort has been made to avoid reproducing stereotypes that lead to disparities in healthcare.

THE NPLEX PROCESS

The NPLEX examinations have been developed in accordance with industry standards. The following is an overview of the process.

EXAM DEVELOPMENT: The development of the blueprints includes practice analyses, which are studies that examine the tasks and responsibilities of naturopathic medical doctors. The content of the exams is managed by NPLEX Exam Development Specialists with input by a team of volunteer Subject Matter Experts (SMEs). All questions on the exams have been sourced from at least two professional medical references, and undergo a minimum of five rounds of review. Content is reviewed for both medical accuracy as well as grammar and punctuation.

SCORING THE EXAMINATIONS: There are two parts involved in scoring the exams, the Post-Test Analysis and Establishing the Passing Score.

POST-TEST ANALYSIS: After the administration, the psychometrician (an expert in exam statistics) utilizes statistical analysis to identify any "problem" questions on the exam. Each of these is reviewed by a panel of SMEs for both clarity and content. Based on this review, it may be determined that the correct answer should be changed, or credit may be given for more than one answer, or no change in scoring will be made. This process helps ensure that the results are valid and fair.

ESTABLISHING THE PASSING SCORE: There is no predetermined passing score. This is different from academic tests, where, for example, a 70% might be needed in order to pass. There is also no "grading on a curve," for instance, where the top 80% will pass. Instead, the Angoff method, an internationally recognized statistical process, is used to determine the passing score. This method is specifically designed for professional licensing exams where the goal is to determine *minimal competence*. Minimal competence is the term used for professional licensing exams, to gauge the knowledge, skill, and ability necessary to safely practice as a licensed/registered naturopathic medical doctor. In this method, a panel of SMEs rates each question on the exam, estimating the probability that a minimally competent candidate would be able to answer the question correctly. These ratings are then used to determine the passing score ("cut score"). Exams that are judged to be more difficult will have lower cut scores than less difficult exams (i.e., for a more difficult exam, the examinee will be required to answer fewer questions correctly in order to pass). Because each exam is unique, the cut score will vary somewhat between administrations.

REPORTING THE SCORES: It takes approximately 7 weeks to complete the scoring process. Once the process is complete, the scores are released to NABNE.

SUGGESTIONS FOR A STUDY STRATEGY

The Part I - Biomedical Science Examination is designed to measure readiness to enter the clinical phase of training by assessing your mastery of the competencies identified by biomedical science faculty from the accredited naturopathic medical colleges.

- Plan on taking the Biomedical Science Examination as soon as you are eligible.
  - The more recently you have learned the information, the easier it is to recall.
  - See the *NABNE Examinee Handbook* for details on eligibility.

- Familiarize yourself with the NPLEX competencies.

- Familiarize yourself with the testing format and procedures.
  - The Part I - Biomedical Science Examination will have 200 multiple-choice questions.
  - Each of these questions has only one best answer.
  - Review the sample questions included in this study guide.

- This blueprint is the only study material produced by NPLEX.
  - Many other sources produce study materials, but NPLEX cannot verify whether those materials accurately represent the content of the NPLEX exam.
  - This does not mean that those materials may not be helpful, it just means that they are not in any way affiliated with NPLEX.

SUGGESTIONS FOR TAKING AN NPLEX MULTIPLE-CHOICE EXAMINATION

The most important thing to remember is that you MUST mark an answer.

There are many different strategies for how and when to mark an answer. NPLEX recommends the following:

- Mark the answers as you read the exam.
  - Do not wait to mark your answers until the end of the test.
  - Mark each answer as you go through the test. You can go back to change answers, if needed.
  - Do not let yourself fail because you run out of time to mark all of your answers.

- An unanswered question will be scored as incorrect.
  - Marking any answer is better than marking none at all.

- If you don’t know an answer with certainty, try to eliminate some of the response choices.
  - If after eliminating one or two of the choices you still are not sure of the answer, make your best guess from among the remaining choices.

- You will encounter a range of question types and difficulty. Some questions will require simple memory/recall, and some questions will require applied knowledge, for example, applying the content to a clinical scenario.
  - Some questions may seem easy. That's okay!
  - Try not to overthink your answers, or talk yourself out of an answer.
  - There are no "trick" questions. Every effort has been made to present questions in a straightforward manner.

EXAMINATION FORMAT

- The BSE has a total of 200 questions.
- It will be administered in two sessions.
- Each session will consist of 100 questions.
- You will have 2.5 hours to complete each session.
- Both sessions will be administered on the same day, for example: one session in the morning and one session in the afternoon.
- The entire exam will consist of 50 case clusters in which you will be presented with a brief summary of the case, including the patient's diagnosis.
- You will then be asked four questions on aspects of the biomedical sciences that pertain to that case.
    - For example, you might be asked to identify:
        - anatomical locations or blood supply.
        - the etiology or complications.
        - the causative organism.
        - the related biochemical pathway.
        - normal physiological processes.

PASSING STANDARDS

The exam is comprised of two General Exam Areas (GEAs): Structure/Function and Disease/ Dysfunction. Each of these GEAs will include two or three Specific Exam Areas (SEAs), as follows:

GEA: Structure/Function:
- SEA: Anatomy
- SEA: Physiology
- SEA: Biochemistry & Genetics

GEA: Disease/Dysfunction:
- SEA: Microbiology & Immunology
- SEA: Pathology

There will be a total of 200 questions on the exam, comprised of approximately 40 questions from each SEA. Structure/Function questions will be approximately 60% of the exam, and Disease/Dysfunction will be approximately 40% of the exam.

In order to pass the exam, you will be required to demonstrate competence in **both** of the General Exam Areas (GEAs). This means that you will need to earn a minimum cumulative score in each GEA in order to pass. For instance, if the passing standard (cut score) is determined to be 80 for Structure/Function and 60 for Disease/Dysfunction, your combined score from Anatomy, Physiology, and Biochemistry & Genetics will need to be at least 80 and your combined score from Microbiology & Immunology and Pathology will need to be at least 60.

If you do not achieve a passing score in **both** GEAs, you will not pass and will be required to retake the entire exam.

COMPETENCIES—OVERVIEW

The NPLEX exam is competency based. A competency-based exam is an assessment designed to evaluate ability to perform specific skills or tasks in a profession, focusing on a practical application of knowledge rather than just memorization. The exam will utilize clinical scenarios as a framework for demonstrating proficiency in naturopathic medical principles and application.

Some of the knowledge necessary to perform the tasks required for entering the clinical phase of naturopathic medical training may not be specified here. For instance, knowing how to properly check a person's blood pressure is a necessary skill for entering the clinical phase of naturopathic medical training, but might not be tested on this examination.

The list of competencies is comprehensive, but it is not an outline for what the actual exam will look like. The order in which the competencies are listed does not represent the order of questions on the examination. Not every competency will be represented on every exam. Questions might be asked on the examination that do not fit into a single body system, but instead relate to several systems.

On the list of competencies on the following pages, the percentages for each system (in parentheses) are approximate, but provide a reasonable representation of exam focus.

In order to better understand how these competencies might be applied on the examination, several examples are provided below.

Competency: Describe the location, function, autonomic regulation, and electrical measurement of the conduction system of the heart.

Example: The student should know the structures and understand the mechanisms that are involved in normal and abnormal cardiac rhythms.

Competency: Explain the functions and regulatory mechanisms of the cardiac cycle.

Example: The student should understand how hypertension affects the afterload of the heart, and how it impacts cardiac output.

Competency: Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to cardiovascular function and pathology.

Example: The student should understand lipid transport in normal physiology and in pathological conditions such as atherosclerosis.

Example: The student should understand how abnormal heme synthesis can result in the development of porphyria.

Competency: Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of congestive heart failure (CHF).

Example: The student should understand the relationship between underlying pathology and the development of the signs and symptoms associated with CHF.

COMPETENCIES—DETAIL

CARDIOVASCULAR SYSTEM (12%)

In regard to the cardiovascular system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the cardiovascular system, including the valves and chambers of the heart and the blood vessels.

2. Describe the microscopic anatomy of the heart and blood vessels.

3. Describe the location, characterize the structure, and delineate the boundaries of the heart, the major vessels, and the pericardium.

4. Describe the location and explain the function of the heart valves in relation to the cardiac cycle.

5. Explain the physiological basis of contraction in cardiac muscle.

6. Explain the functions and regulatory mechanisms of the cardiac cycle.

7. Describe the location, function, autonomic regulation, and electrical measurement of the conduction system of the heart.

8. Describe the location and branching patterns of coronary arteries, and trace the circulatory pathways of the blood supply of the heart.

9. Describe the anatomical patterns of blood distribution to the somatic and visceral areas of the body.

10. Describe the location, structure, circulatory pathways, and functions of the lymphatic vessels, tissues, and organs.

11. Describe the forces involved in the circulation of blood and lymph, and the regulation of blood flow.

12. Explain the acute and adaptive effects that exercise has on the cardiovascular system.

13. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to cardiovascular function and pathology.

14. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of the genetic abnormalities that underlie cardiovascular disease processes.

15. Explain the relationship between the cardiovascular and pulmonary systems.

16. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

17. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

18. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed below.

A. hypertensive heart diseases
1. pulmonary hypertension
2. systemic hypertension

B. congestive heart failure (CHF)
1. left-sided
2. right-sided

C. ischemic heart disease
1. angina pectoris
2. chronic ischemic heart disease
3. myocardial infarction (MI)

D. valvular heart diseases
1. aortic stenosis/insufficiency
2. mitral stenosis/insufficiency
3. endocarditis
4. mitral valve prolapse (MVP)
5. rheumatic heart disease
6. carcinoid heart disease

E. primary myocardial diseases
1. cardiomyopathies (dilated,restrictive, hypertrophic)
2. myocarditis

F. pericardial disease
1. metastatic disease
2. pericardial effusions
3. pericarditis (primary &secondary)

G. congenital heart conditions
1. bicuspid aortic valve
2. patent ductus arteriosus
3. septal defects (interventricular,atrial)
4. tetralogy of Fallot

H. hemodynamic conditions
1. embolism
2. hemorrhage
3. infarction
4. edema
5. shock
6. thrombosis

I. vascular conditions
1. aneurysm
2. aortic dissection
3. arteriosclerosis andatherosclerosis
4. familial hypercholesterolemia
5. giant cell arteritis (temporalarteritis)
6. peripheral arterial disease (PAD)
7. pulmonary embolism (PE)
8. Raynaud phenomenon (primaryand secondary)
9. thromboangiitis obliterans
10. thrombosis - deep vein (DVT)
11. varicose veins
12. vasculitis

J. vascular neoplasms
1. hemangiomas
2. Kaposi sarcoma

K. infectious vascular diseases
1. bacterial endocarditis
2. Chagas disease
3. Lyme disease
4. Rocky Mountain spotted fever
5. viral hemorrhagic fever (yellow fever, Dengue fever, filoviruses)
6. viral myocarditis

ENDOCRINE SYSTEM (8%)

In regard to the endocrine system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the organs of the endocrine system.
2. Describe the microscopic anatomy and derivations of the endocrine organs.
3. Describe the location and structure of the endocrine organs.
4. Describe the location and structure of the circulatory pathways of blood to the endocrine organs.
5. Explain the mechanisms, factors affecting, functions, and control of endocrine organs.
6. Explain the composition, function, effects, transport, and regulation of endocrine hormones, including feedback mechanisms.
7. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to endocrine function and pathology.
8. Explain the biochemistry of synthesis and degradation of hormones involved in the endocrine system.
9. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of genetic abnormalities that underlie endocrine disease processes.
10. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.
11. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.
12. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. diseases of hyperfunction of endocrine organs
1. hyperadrenalism (Cushing syndrome, Conn syndrome, congenital adrenal hyperplasia)
2. hyperparathyroidism (primary and secondary)
3. hyperpituitarism (acromegaly, gigantism)
4. hyperthyroidism (multinodular goiter, Graves disease)

B. diseases of hypofunction of endocrine organs
1. diabetes insipidus
2. hypoadrenalism (Addison disease, primary acute insufficiency, secondaryadrenocortical insufficiency)
3. hypoparathyroidism
4. hypopituitarism (empty sella syndrome, hypothalamic lesions)
5. hypothyroidism (iodine-deficiency goiter)

C. inflammatory endocrine diseases
1. Hashimoto thyroiditis
2. granulomatous subacute thyroiditis

D. metabolic endocrine disease
1. diabetes types 1 and 2 (diabetes mellitus [DM])

E. congenital endocrine disease
1. thyroglossal duct cyst

F. endocrine vascular diseases
1. postpartum pituitary necrosis (Sheehan necrosis)

G. endocrine neoplasms
1. adrenal
2. pancreas (insulinoma)
3. parathyroid
4. pituitary (adenoma, non-functioning tumor, craniopharyngioma)
5. thyroid (adenoma and follicular, papillary and medullary carcinomas, euthyroid goiter)
6. other neoplasms (multiple endocrine neoplasia, types 1 & 2 pheochromocytoma)

H. infectious endocrine diseases
1. infectious thyroiditis
2. Waterhouse-Friderichsen syndrome

GASTROINTESTINAL SYSTEM (12%)

In regard to the gastrointestinal system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the gastrointestinal tract and glands.

2. Describe the microscopic anatomy of the gastrointestinal tract and glands.

3. Describe the location, structure, and boundaries of the organs and glands of the gastrointestinal system.

4. Describe the gastrointestinal system in relation to the oral, mediastinal, and abdominopelvic cavities.

5. Describe the location, structure, and circulatory pathways of the blood supply of the gastrointestinal system.

6. Explain the mechanisms, functions, regulation, and factors affecting mastication, deglutition, digestion, absorption, peristalsis, and defecation.

7. Explain the composition, function, transport, and regulation of products of digestion.

8. Explain the biochemistry of digestive processes, including the endogenous production of chemical energy, and the chemical composition and dietary requirements of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors.

9. Explain the non-digestive functions of the salivary glands, liver, and gall bladder, including bilirubin metabolism and detoxification pathways.

10. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of genetic abnormalities that underlie gastrointestinal disease processes.

11. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

12. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

13. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. salivary gland disease
1. parotitis

B. pancreatic disease
1. pancreatitis

C. hepatic diseases and disorders
1. cholestasis
2. cirrhosis
3. Gilbert syndrome
4. hepatitis (non-infectious)
5. portal hypertension

D. gallbladder diseases
1. cholecystitis
2. cholelithiasis

E. deficiency and malabsorption conditions
1. achlorhydria
2. gluten-sensitive enteropathy(celiac disease)
3. enzyme deficiencies
4. lactase deficiency

F. obstructive gastrointestinaldiseases
1. achalasia
2. adynamic ileus
3. hernia
4. intussusception/volvulus
5. megacolon

G. inflammatory gastrointestinaldiseases
1. appendicitis
2. Barrett esophagus
3. diverticular disease
4. enteritis
5. esophageal/gastric/duodenalulcers
6. esophagitis (non-infectious)
7. gastritis
8. gastroesophageal reflux disease (GERD)
9. inflammatory bowel disease(regional enteritis [Crohn disease], ulcerative colitis)

H. congenital gastrointestinal disease
1. esophageal atresia
2. esophageal webs and rings
3. Meckel diverticulum
4. pyloric stenosis

I. conditions of the abdominal cavity
1. ascites
2. peritonitis/adhesions

J. gastrointestinal vascular diseases
1. esophageal varices
2. hemorrhoids
3. infarction
4. vascular ectasias of the colon

K. gastrointestinal neoplasms
1. esophageal
2. gastric
3. intestinal (gastrinoma)
4. liver
5. oral (leukoplakia)
6. pancreas
7. colorectal

L. infectious gastrointestinal diseases
1. enterocolitis
2. esophagitis
3. gastroenteritis
4. gingivitis/periodontitis
5. oral thrush
6. stomatitis
7. viral hepatitis

HEMATOPOIETIC SYSTEM (6%)

In regard to the hematopoietic system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the microscopic anatomy, origins, and maturation of blood cells.

2. Describe the composition, and explain the function and regulation of blood cells and plasma.

3. Describe the synthesis and degradation of blood cells.

4. Explain the mechanisms and factors affecting hematopoiesis and hemostasis.

5. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to hematopoietic function, hemostasis, and hemoglobin function**,** formation, and pathology.

6. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of the genetic abnormalities that underlie hematopoietic disease processes.

7. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

8. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

9. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. diseases involving production of blood cells
1. anemias (macrocytic, microcytic, aplastic)
2. polycythemia (vera, secondary)

B. diseases involving lysis of blood cells
1. hemolytic anemia (sickle cell, thalassemia, glucose-6-phosphate-dehydrogenasedeficiency [G6PD], spherocytosis)
2. hemolytic disease of the newborn (erythroblastosis fetalis)

C. clotting abnormalities
1. disseminated intravascular coagulation (DIC)
2. hemophilia
3. immune thrombocytopenic purpura (ITP)
4. von Willebrand disease
5. vitamin K deficiency

D. blood & lymph neoplasms
1. leukemias
2. lymphomas (Hodgkin, non-Hodgkin)
3. multiple myeloma

E. infectious diseases of the blood
1. babesiosis
2. malaria
3. schistosomiasis

IMMUNOLOGICAL SYSTEM (8%)

In regard to the immunological system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the thymus.

2. Describe the microscopic anatomy of the lymphoid organs.

3. Describe the structure and function of histocompatibility antigens and their associated diseases.

4. Describe the location and drainage patterns of lymphatic vessels.

5. Explain the functions of cells, antibodies, and cytokines in humoral and cell-mediated immunity.

6. Explain the pathways of cellular and cytokine signaling in response to injury, infection, and foreign bodies.

7. Explain the structure, function, and pathways of complement compounds.

8. Explain the mechanisms, factors affecting, functions, and control of lymphatic organs.

9. Explain the composition, function, and transport of lymphatic fluid.

10. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors, and the biochemical processes and associated constituents involved in immunological function and pathology.

11. Explain the biochemistry of synthesis and degradation of lymphatic fluid and its components.

12. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of the genetic abnormalities that underlie immunological disease processes.

13. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

14. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

15. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. immunodeficiency diseases of congenital origin
1. common variable immunodeficiency
2. DiGeorge syndrome
3. selective IgA deficiency
4. severe combined immunodeficiency
5. X-linked agammaglobulinemia

B. immunodeficiency diseases of acquired origin
1. drug-induced immunodeficiencies
2. human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS)

C. diseases of hypersensitivity
1. type I (anaphylaxis)
2. type II (autoimmune hemolytic anemia, Goodpasture syndrome, myasthenia gravis[MG])
3. type III (systemic lupus erythematosus [SLE], polyarteritis nodosa, poststreptococcal glomerulonephritis, rheumatoid arthritis)
4. type IV (granulomatous inflammation, transplant rejection)

D. other autoimmune diseases
1. progressive systemic sclerosis (scleroderma)
2. rheumatic fever
3. Sjögren syndrome

E. diseases of amyloids
1. primary amyloidosis
2. secondary amyloidosis

F. systemic infectious diseases
1. erythema infectiosum (fifth disease)
2. Haemophilus influenzae type b
3. influenza
4. measles
5. mononucleosis
6. mumps
7. roseola infantum
8. rubella
9. scarlet fever
10. toxoplasmosis

INTEGUMENTARY SYSTEM (6%)

In regard to the integumentary system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the microscopic anatomy, derivations, and differentiating features of the layers of the skin and dermal-epidermal junction.

2. Describe the embryological development of the ectoderm.

3. Explain the function of membrane constituents and the mechanisms governing transport across cell membranes, osmosis, membrane potential, and ionic equilibrium.

4. Explain the principles of thermal physiology, including regulation of body temperature.

5. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to the integumentary system.

6. Explain the biochemistry of non-vitamin antioxidants and free radical scavengers as they relate to integumentary function and pathology.

7. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of genetic abnormalities that underlie integumentary disease processes.

8. Explain the processes relating to adaptive changes, cellular injury, pigmentation, infiltration, and neoplasia.

9. Explain the principles of infectious disease in dermatological pathologies including normal flora, stages of infection, and characteristics of pathogenesis.

10. Explain the complications and clinical characteristics of skin trauma and healing mechanisms.

11. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

12. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

13. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. pigmentation changes of the skin
1. nevocellular nevus
2. vitiligo

B. acute inflammatory dermatological conditions
1. atopic dermatitis (eczema)
2. contact dermatitis
3. erythema multiforme
4. urticaria

C. chronic inflammatory dermatological conditions
1. acne rosacea
2. lichen planus
3. psoriasis

D. blistering diseases
1. epidermolysis bullosa
2. pemphigoid
3. pemphigus

E. genetic dermatological conditions
1. albinism
2. Ehlers-Danlos syndrome

F. benign and pre-malignant lesions of the skin
1. actinic keratosis
2. dysplastic nevi
3. seborrheic keratosis

G. malignant neoplasms of the skin
1. basal cell carcinoma
2. squamous cell carcinoma
3. melanoma

H. infectious dermatological diseases
1. acne vulgaris
2. candidiasis
3. cellulitis
4. erysipelas
5. erythema nodosum
6. folliculitis
7. impetigo
8. methicillin-resistant Staphylococcus aureus (MRSA)
9. molluscum contagiosum
10. tinea
11. verrucae
12. wound infection/needle stick

MUSCULOSKELETAL SYSTEM (10%)

In regard to the musculoskeletal system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the musculoskeletal system including muscle, bone, and joints.

2. Describe the microscopic anatomy of the musculoskeletal system including skeletal, cardiac, and smooth muscle; compact and spongy bone; and fibrous, cartilaginous, and synovial joints.

3. Describe the location and structure, and explain the function of vertebrae, the bones of the skull, vertebral column, pectoral girdle, upper extremity, pelvic girdle, and lower extremity.

4. Describe the location, structure, and innervation of the joints, and explain the functions of the different types of joints in the body.

5. Describe the origin, insertion, main action, and innervation of the muscles of the body regions: head and neck; upper and lower extremities; and back, thorax, abdomen, and pelvis.

6. Describe the embryology and structure, and explain the function of connective tissues of the musculoskeletal system.

7. Explain the mechanisms and factors affecting contraction of skeletal, smooth, and cardiac muscle.

8. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to musculoskeletal function and pathology.

9. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of the genetic defects that underlie musculoskeletal disease processes.

10. Explain the relationship between the musculoskeletal and neurological systems.

11. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

12. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

13. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. musculoskeletal nutritional deficiencies
1. osteomalacia
2. rickets
3. scurvy

B. inflammatory musculoskeletal diseases
1. ankylosing spondylitis
2. bursitis
3. fibromyalgia
4. gout
5. myositis (dermatomyositis, polymyositis)
6. polymyalgia rheumatica (PMR)
7. reactive arthritis (Reiter syndrome)
8. tendonopathy

C. metabolic musculoskeletal diseases
1. osteopetrosis

D. congenital musculoskeletal diseases
1. Marfan syndrome
2. muscular dystrophy
3. osteogenesis imperfecta

E. degenerative musculoskeletal diseases
1. osteoarthritis (OA)/degenerative joint disease (DJD)
2. osteoporosis
3. Paget disease
4. avascular necrosis

F. musculoskeletal neoplasms
1. chondrosarcoma
2. Ewing sarcoma
3. osteoid osteoma
4. osteosarcoma
5. rhabdomyosarcoma

G. infectious musculoskeletal diseases
1. septic (infectious) arthritis
2. necrotizing fasciitis
3. osteomyelitis
4. wet and gas gangrene

H. trauma
1. injury to the musculoskeletal system

NEUROLOGICAL SYSTEM (10%)

In regard to the neurological system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the neural tube and its derivatives.

2. Describe the microscopic anatomy of motor and sensory neurons and nerves.

3. Describe the location and structure, and explain the function of the neural structures within the cranial cavity and vertebral canal.

4. Describe the location and structure, and explain the function of the cerebrospinal fluid compartments and meninges.

5. Describe the location and explain the functions of sensory receptors and the associated anatomical pathways for somatic and visceral sensory perception and reflexes.

6. Describe the location, structure, and pathways, and explain the functions of the special senses (visual, auditory, gustatory, olfactory, and vestibular systems) and associated glands.

7. Describe the location, pathways, and functions of the somatic motor and sensory components and the visceral motor and sensory components.

8. Describe the location and explain the function of cranial and spinal nerves.

9. Describe the location and pathways, and explain the functions of the autonomic nervous system.

10. Describe the pathways of the blood supply and the origin and flow of cerebrospinal fluid for the central nervous system.

11. Describe the pathways and explain the functions and patterns of activity for the association cortex.

12. Explain the mechanisms, factors affecting, function, and control of hypothalamic and limbic pathways.

13. Explain the mechanisms, factors affecting, function, and control of synaptic transmission, graded potentials, action potential, and axon conduction.

14. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to neurological function and pathology.

15. Explain the biochemistry of neurotransmitter synthesis, function, and degradation.

16. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of genetic abnormalities that underlie neurological disease processes.

17. Explain the relationship of the neurological system to the endocrine system.

18. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

19. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed below.

20. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed below.

A. neurological vascular disease
1. cerebral infarction (thrombosis, embolism, common obstructions)
2. cerebral vascular accident (CVA) (ischemic/hemorrhagic)
3. ischemic-hypoxicencephalopathy
4. intracranial hemorrhage(cerebral, subarachnoid,epidural/subdural)
5. vascular lesions of the spinalcord

B. degenerative and demyelinationdiseases
1. Alzheimer disease
2. amyotrophic lateral sclerosis(ALS)
3. extrapyramidal diseases (spinocerebellar degeneration, Huntington chorea, Parkinsonism)
4. Guillain-Barré syndrome
5. multiple sclerosis (MS)
6. acute disseminatedencephalomyelitis

C. diseases of increased intracranialfluid
1. cerebral edema
2. hydrocephalus

D. metabolic and nutritionalneurological diseases
1. hepatic encephalopathy
2. peripheral neuropathy
3. vitamin B_{12} deficiency
4. Wernicke-Korsakoff syndrome

E. congenital and genetic neurological diseases
1. Down syndrome
2. leukodystrophies
3. phenylketonuria (PKU)
4. storage diseases
5. Wilson disease

F. neurological neoplasms
1. medulloblastoma
2. meningiomas
3. neuroblastoma
4. neuroglial tumors (astrocytomas, oligodendrogliomas)
5. neuronal tumors
6. tumors of peripheral nerves (schwannoma, neurofibromatosis)

G. infections of the CNS & PNS
1. arboviruses
2. botulism
3. brain abscess
4. encephalitis
5. fungal infections
6. herpes viruses
7. leprosy
8. meningitis
9. neurosyphilis
10. poliomyelitis
11. prion disease
12. progressive multifocal leukoencephalopathy (PML)
13. subacute sclerosing panencephalitis (SSPE)
14. tetanus
15. varicella zoster virus (VZV)

H. CNS trauma
1. traumatic brain injury (TBI)(concussion, contusion, hemorrhage, hematoma)
2. spinal cord compression/transection

I. PNS trauma/compression
1. Bell palsy
2. carpal tunnel syndrome (CTS)
3. disc herniation
4. nerve root entrapment
5. sciatica
6. thoracic outlet syndrome (TOS)
7. trigeminal neuralgia

J. diseases of the special senses
1. blepharitis
2. cataracts
3. conjunctivitis
4. glaucoma
5. iritis/keratitis
6. macular degeneration
7. uveitis
8. Ménière disease (idiopathic endolymphatic hydrops)
9. otitis
10. vestibular neuritis & labyrinthitis

PULMONARY SYSTEM AND UPPER RESPIRATORY TRACT (8%)

In regard to the pulmonary system and upper respiratory tract, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should beable to:

1. Describe the embryological development of the respiratory tract.
2. Describe the microscopic anatomy of the respiratory tract.
3. Describe the boundaries and anatomical structures associated with the organs of the upper respiratory tract.
4. Describe the boundaries and components of the thorax in relation to the pleura, lungs, heart, and mediastinum.
5. Describe the circulation of blood and the flow of air in the lungs.
6. Explain the mechanisms, functions, regulation, and factors affecting ventilation.
7. Explain the mechanisms, functions, regulation, and factors affecting gas exchange and tissue perfusion.
8. Explain the transport and regulation of blood gases.
9. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to pulmonary function and pathology.
10. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of the genetic abnormalities that underlie pulmonary disease processes.
11. Explain the biochemistry of energy production and utilization as it relates to the respiratory system.
12. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.
13. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.
14. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. restrictive pulmonary diseases
1. respiratory distress syndrome
2. idiopathic pulmonary fibrosis
3. pneumoconiosis
4. sarcoidosis

B. obstructive pulmonary diseases
1. asthma
2. bronchiectasis
3. chronic bronchitis
4. emphysema

C. diseases of the upper respiratorytract
1. bronchitis
2. epiglottitis
3. laryngitis
4. rhinitis
5. sinusitis
6. pharyngitis
7. tonsillitis

D. disorders of the pleural cavityand lung expansion
1. chylothorax
2. hemothorax
3. obstructive atelectasis
4. pleural fibrosis (asbestosis)
5. pneumothorax

E. pulmonary vascular disease
1. pulmonary edema
2. pulmonary emboli
3. pulmonary infarction

F. neoplasms of the pulmonary system and upper respiratorytract
1. adenocarcinomas
2. bronchial carcinoid
3. esophageal
4. laryngeal
5. mesothelioma
6. nasopharyngeal carcinoma
7. polyps
8. small-cell carcinoma(squamous)
9. non-small-cell carcinoma(squamous)

G. congenital pulmonary diseases
1. cystic fibrosis (CF)
2. tracheoesophageal fistula

H. infectious diseases of the pulmonary system and upperrespiratory tract
1. atypical pneumonia
2. bronchopneumonia
3. diphtheria
4. fungal pneumonia
5. lobar pneumonia
6. lung abscess
7. pertussis
8. respiratory syncytial virus(RSV)
9. tuberculosis (TB)
10. coronaviruses

REPRODUCTIVE SYSTEM (10%)

In regard to the reproductive system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the organs of the male and female reproductive systems, the placenta, and the breast.

2. Describe the gross and microscopic anatomy of the male and female reproductive organs and the breast.

3. Explain developmental processes related to gametogenesis, implantation, and embryogenesis.

4. Describe the location, structure, and boundaries of the male and female reproductive systems and the breast.

5. Describe the innervation and pathway of blood supply in the reproductive organs and the breast.

6. Explain the mechanisms, function, regulation, and factors affecting reproductive processes and lactation.

7. Explain the composition, function, effects, transport, and regulation of reproductive hormones.

8. Explain the biochemistry of synthesis and degradation of the hormones and other secretions involved in reproductive function and pathology.

9. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to reproductive function and pathology.

10. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of genetic abnormalities that underlie reproductive disease processes.

11. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

12. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

13. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of conditions listed on the next page.

A. reproductive hormone (endocrine) conditions
1. amenorrhea
2. anovulation
3. dysfunctional uterine bleeding
4. menopause/perimenopause
5. ovarian insufficiency/failure
6. polyendocrine metabolic ovarian syndrome (PMOS)/polycystic ovary syndrome (PCOS)

B. inflammatory diseases of the reproductive tract
1. balanitis
2. cervicitis
3. endometriosis
4. endometritis
5. orchitis
6. pelvic inflammatory disease
7. salpingitis
8. vaginitis (candidal)

C. congenital and genetic diseases
1. cryptorchidism
2. epispadias
3. fragile X syndrome
4. hypospadias
5. imperforate hymen
6. Klinefelter syndrome
7. paraphimosis
8. phimosis
9. pseudohermaphroditism
10. septate vagina and uterus
11. Turner syndrome

D. benign conditions of the penis and scrotum
1. erectile dysfunction
2. hematocele
3. hydrocele
4. spermatocele
5. varicocele

E. conditions of the breast
1. diffuse cystic mastopathy (fibrocystic breast disease)
2. galactocele
3. mammary duct ectasia
4. mastitis
5. traumatic fat necrosis
6. benign and malignant neoplasms (fibroadenoma, lobular carcinoma, ductal carcinoma, Paget disease of the breast)

F. infectious diseases and hyperplasia of the prostate
1. benign prostatic hyperplasia
2. prostatitis

G. conditions of the ovary
1. ovarian cysts
2. paraovarian cysts
3. tubo-ovarian cysts

H. diseases of the placenta
1. choriocarcinoma
2. hydatidiform mole
3. invasive mole
4. preeclampsia

I. benign conditions of the vaginaand vulva
1. Bartholin cysts
2. cystocele
3. rectocele
4. urethrocele

J. reproductive dysplasia andneoplasms
1. cervical intraepithelial neoplasia (CIN)
2. endometrial hyperplasia
3. fibroids (leiomyoma)
4. invasive carcinoma of the cervix
5. leiomyosarcomas
6. prostate carcinoma
7. tumors of the ovary
8. squamous cell carcinoma of thepenis
9. testicular tumors
10. vaginal carcinoma
11. vulvar carcinoma
12. vulvar intraepithelial neoplasia

K. infectious diseases of the genitourinary system (includingSTDs)
1. chancroid
2. bacterial vaginosis (BV)
3. chlamydia
4. gonorrhea
5. herpes simplex virus (HSV)
6. human papillomavirus (HPV)
7. nongonococcal urethritis
8. syphilis
9. toxic shock syndrome (TSS)
10. trichomoniasis

URINARY SYSTEM (10%)

In regard to the urinary system, the naturopathic medical student who has completed biomedical course work and is entering the clinical phase of training should be able to:

1. Describe the embryological development of the organs of the urinary system.

2. Describe the microscopic anatomy of the urinary tract.

3. Describe the location, structure, and boundaries of the urinary system.

4. Describe the location, structure, and boundaries of the abdominopelvic cavity in relation to the urinary system.

5. Describe the circulation of blood in the urinary system.

6. Explain the mechanisms, functions, regulation of, and factors affecting micturition, and urinary filtration, re-absorption, and secretion.

7. Describe the role of the kidney in acid-base balance and regulation of blood pressure.

8. Explain the biochemistry of proteins, carbohydrates, lipids, vitamins, minerals, and co-factors as they relate to urinary function and pathology.

9. Describe the features and explain the principles of gene expression and control, and cell cycle regulation, and explain the consequences of genetic abnormalities that underlie urinary disease processes.

10. Describe the activation of innate and adaptive immune mechanisms by microbial pathogens, cancer/tumors, antigens, and vaccines, and describe inflammatory, autoimmune and hypersensitivity immune responses.

11. Explain the morphology, replication/life cycle, transmission (including vectors), mechanisms of infection, virulence factors, and genetic characteristics of the common microbial pathogens that cause the conditions listed on the next page.

12. Explain the pathogenesis and be able to identify the etiology, risk factors, complications, and clinical characteristics of the conditions listed on the next page.

A. glomerular diseases
1. acute kidney injury (AKI)
2. chronic renal failure
3. glomerulonephritis
4. glomerulosclerosis
5. nephrotic syndromes

B. tubulointerstitial disease
1. tubular necrosis

C. obstructive urinary diseases
1. hydronephrosis
2. renal calculi

D. inflammatory urinary tract diseases
1. drug-induced nephritis
2. chronic pyelonephritis

E. congenital urinary disease
1. Alport syndrome
2. cystic renal disease
3. renal agenesis
4. vesicoureteral reflux (VUR)

F. urinary vascular diseases
1. hemolytic uremic syndrome (HUS)
2. hypertensive nephrosclerosis
3. renal artery stenosis
4. renal infarction
5. sickle cell nephropathy

G. neoplasms of the urinary tract
1. renal cell carcinoma
2. nephroblastoma (Wilms tumor)

H. infectious urinary diseases
1. acute pyelonephritis
2. cystitis
3. urethritis

ABBREVIATIONS THE EXAMINEE IS EXPECTED TO KNOW

In addition to common biomedical science nomenclature (e.g., CO_2, Fe^{2+}, HCl, etc.), examinees are expected to know what the following abbreviations mean:

ACE	angiotensin converting enzyme
AChE	acetylcholinesterase
ACTH	adrenocorticotropic hormone
ADH	anti-diuretic hormone
ADP	adenosine diphosphate
AFP	alpha fetoprotein
ALT	alanine aminotransferase
AMP	adenosine monophosphate
ANA	anti-nuclear antibody
ANS	autonomic nervous system
AST	aspartate aminotransferase
ATP	adenosine triphosphate
AV	atrioventricular
BMR	basal metabolic rate
BPM	beats per minute
BUN	blood urea nitrogen
cAMP	cyclic adenosine monophosphate
CAT	choline acetyltransferase
CBC	complete blood count
CD4	cluster of differentiation 4
CD8	cluster of differentiation 8
CEA	carcinogenic embryonic antigen c
cGMP	guanosine cyclic monophosphate
CDC	Centers for Disease Control and Prevention
CIN	cervical intraepithelial neoplasia
CMP	cytosine monophosphate
CMV	cytomegalovirus
CN	cranial nerve
CNS	central nervous system
CPR	cardiopulmonary resuscitation
CRP	C-reactive protein
CSF	cerebrospinal fluid
DHT	dihydrotestosterone
DJD	degenerative joint disease
DNA	deoxynucleic acid
DPT	diphtheria-pertussis-tetanus
DTR	deep tendon reflex
EBV	Epstein-Barr virus
ECG/EKG	electrocardiogram
EEG	electroencephalogram
EMG	electromyogram
ESR	erythrocyte sedimentation rate
FAD	flavin adenine dinucleotide
$FADH_2$	flavin adenine dinucleotide (reduced form)
FEV	forced expiratory volume
FSH	follicle-stimulating hormone
FVC	forced vital capacity
GABA	gamma-amino butyric acid
GBM	glomerular basement membrane
GFR	glomerular filtration rate
GGT	gamma-glutamyl transferase
GH	growth hormone
GMP	guanosine 5'-monophosphate
GnRH	gonadotropin-releasing hormone
Hb	hemoglobin
HbA1c	hemoglobin A1c
hCG	human chorionic gonadotropin
Hct	hematocrit
HDL	high density lipoprotein
HIV	human immunodeficiency virus
HLA	human leukocyte antigen
Ig	immunoglobulin
IL	interleukin
IM	intramuscular
IV	intravenous
IFN	interferon
LCR	ligase chain reaction
JAK	Janus kinase
JAK/STAT	Janus kinase/signal transducer and activator of transcription protein
LDL	low density lipoprotein
LH	luteinizing hormone
LHRH	luteinizing hormone releasing hormone
LLQ	left lower quadrant
LOC	loss of consciousness
LUQ	left upper quadrant
MAO	monoamine oxidase
MHC	major histocompatibility complex
MIC	minimal inhibitory concentration
MSH	melanocyte-stimulating hormone
MRI	magnetic resonance imaging
MVA	motor vehicle accident
MVC	motor vehicle collision
NAC	N-acetyl cysteine
NADH	nicotinamide adenine dinucleotide
NADPH	nicotinamide adenine dinucleotide phosphate
NSAID	non-steroidal anti-inflammatory drug
NK	natural killer (cells)
OTC	over the counter
PABA	para-amino benzoic acid
PCR	polymerase chain reaction
PG	progesterone
PHAC	Public Health Agency of Canada
PMN	polymorphonuclear neutrophil
PNS	peripheral nervous system
PRPP	phosphoribosyl pyrophosphate
PTH	parathyroid hormone
RANKL	receptor activator of nuclear factor-kappaligand
RBC	red blood cells
RF	rheumatoid factor
Rh	rhesus factor
RLQ	right lower quadrant
RUQ	right upper quadrant
RNA	ribonucleic acid
RSV	respiratory syncytial virus
SA	sinoatrial
SOD	superoxide dismutase
TIBC	total iron-binding capacity
TGF	transforming growth factor
TNF	tumor necrosis factor
TRH	thyrotropin-releasing hormone
TSH	thyroid stimulating hormone
TSST-1	toxic shock syndrome toxin-1
UMP	uracil monophosphate
URI	upper respiratory infection
UTI	urinary tract infection
UTP	uridine triphosphate
VLDL	very low density lipoprotein
VMA	vanillylmandelic acid
WBC	white blood cell
WHO	World Health Organization

EXAMPLES OF BIOMEDICAL SCIENCE CASE CLUSTERS

(answers can be found on page 50)

Although the questions in a cluster relate to a clinical case, clinical experience will not be necessary to answer the questions.

The questions on the following pages are examples of some types of **question formats** you might encounter on the NPLEX Part I - Biomedical Science Examination. We recommend that you read through all the example questions on the following pages to get an idea of the types of question formats you can expect. These examples do not cover the scope of knowledge that will be tested on the exam. Refer to the list of NPLEX Biomedical Science Competencies (beginning on page 9) todetermine the scope of knowledge that will be tested.

Following are some examples of the type of case-based question clusters (case clusters) that will appear on the NPLEX Part I - Biomedical Science Examination. Please note, the examples that follow are not representative of the percentages of questions in each specific exam area (anatomy, physiology, biochemistry, genetics, immunology, microbiology, pathology) that will be asked on the exam.All questions on the exam will be multiple-choice questions with four responses, but questions will beasked in many different formats. On the exam, there will not necessarily be an question in every specific exam area for every case cluster; some case clusters on the exam may consist exclusively of one exam area (e.g., a case cluster might have four microbiology questions). Some of the case clusters that follow have only two or three questions. On the examination, most case clusters will have four questions each. The examples of questions are neither inclusive nor exhaustive of question format;however, a review of all sample case clusters will provide a good indication of the types of questionsthat might be asked on the exam.

Examinees will be required to demonstrate competence in two *general* exam areas (GEAs): Structure/ Function (60%) and Disease/Dysfunction (40%). There will be approximately 40 questions from each of the five *specific* exam areas (SEAs): anatomy, physiology, and biochemistry & genetics (Structure/Function GEA), and microbiology & immunology and pathology (Disease/Dysfunction GEA).

Case #1

PATIENT: age: 32; sex assigned at birth: female
The patient presents with galactorrhea and frequent headaches. She has a year-long historyof amenorrhea. Physical examination reveals bitemporal hemianopsia. Radiologic studies confirm the presence of a pituitary adenoma.

1. Overproduction of which hormone is the most likely cause of the galactorrhea?
   A. prolactin
   B. growth hormone
   C. antidiuretic hormone
   D. follicle-stimulating hormone

2. The bitemporal hemianopsia is explained by compression of the _____.
   A. optic chiasm
   B. left optic nerve
   C. right optic nerve
   D. left and right optic tract

3. The pituitary gland is located _____.
   A. anterior to the lesser wings of the sphenoid
   B. within the petrous portion of the temporal bone
   C. superior to the cribriform plate and the crista galli
   D. in the sella turcica, inferior to the diaphragma sellae

4. What is the embryological origin of the cells in the tumor?
   A. diencephalon
   B. oral ectoderm
   C. neural crest cells
   D. rostral neural tube

Case #2

PATIENT: age: 41; sex assigned at birth: female
Post-mortem microscopic examination of the proximal end of the left anterior descending coronary artery from the patient reveals a thrombotic occlusion arising from an atherosclerotic plaque.

1. Which of the following underlying conditions most likely led to her death?
   A. glomerulonephritis
   B. portal hypertension
   C. calcific aortic stenosis
   D. type 2 diabetes mellitus

2. Hypercholesterolemia was implicated in the pathogenesis of her atherosclerosis. In the synthesis of cholesterol, what is the key regulating enzyme?
   A. phosphodiesterase
   B. HMG-CoA reductase
   C. cholesterol desmolase
   D. cholesterol synthetase

3. What is the source of the left anterior descending coronary artery?
   A. aortic sinus
   B. circumflex artery
   C. left coronary artery
   D. right coronary artery

Case #3

PATIENT: age: 3; sex assigned at birth: male
The patient presents with epistaxis, pain, and vomiting. Physical examination reveals generalized lymphadenopathy. Lab test results confirm a diagnosis of acute lymphoblastic leukemia.

1. Acute lymphoblastic leukemia is characterized by _____.
   A. Bence-Jones proteins in the urine
   B. decreased numbers of all types of blood cells
   C. tumor masses in multiple contiguous lymph nodes
   D. the presence of Reed-Sternberg cells in the bone marrow

2. The follicles contained within the swollen lymph nodes are composed mostly of _____.
   A. B cells
   B. NK cells
   C. CD4+ T cells
   D. CD8+ T cells

3. The vomiting is initiated by stimulation of which motor nerve fibers in the stomach?
   A. celiac ganglion
   B. vagus nerve (CN X)
   C. glossopharyngeal (CN IX)
   D. superior hypogastric plexus

Case #4

PATIENT: age: 20; sex assigned at birth: female
The patient presents with difficulty climbing stairs and rising from a seated position. Onsetwas 6 months ago. Physical examination reveals a dusky red rash over the knuckles, heliotrope discoloration of the upper eyelids, and periorbital edema. She has symmetrical, proximal muscle weakness, and diminished motor strength in all extremities. Deltoid biopsy results confirm a diagnosis of dermatomyositis.

1. Which finding is consistent with a diagnosis of dermatomyositis?
   A. vasculitis
   B. hemochromatosis
   C. amyloid deposition
   D. perifascicular hypertrophy

2. Possession of certain HLA alleles increases the risk of developing dermatomyositis. HLAs corresponding to MHC class II present antigens to _____.
   A. CD4+
   B. CD8+
   C. NK cells
   D. dendritic cells

3. The biopsy shows pathologic changes in the connective tissues and associated muscle tissues. Which type of connective tissue directly surrounds individual muscle fibers?
   A. epimysium
   B. epineurium
   C. perimysium
   D. endomysium

4. Which of the following will most likely cause weakness in a muscle?
   A. increased cytosolic calcium levels
   B. decreased actin-myosin cycling rate
   C. decreased activity of acetylcholinesterase
   D. decreased uptake of calcium into the sarcoplasmic reticulum

Case #5

PATIENT: age: 4 weeks; sex assigned at birth: male
The patient has a ventricular septal defect. Physical examination reveals a systolic murmur, but there is no evidence of cyanosis. Echocardiography shows a left-to-right shunt through a defect in the membranous part of the interventricular septum.

1. The membranous interventricular septum is normally formed by the _____.
   A. sinus venosus
   B. septum primum
   C. septum secundum
   D. endocardial cushions

2. How have his cardiac hemodynamics changed as a result of the left-to-right shunt?
   A. heart rate is decreased
   B. stroke volume is increased
   C. cardiac output is decreased
   D. left ventricular end diastolic volume is increased

3. If he had a right-to-left shunt, what would be the consequence?
   A. cyanosis
   B. left heart failure
   C. hypertrophy of the left ventricle
   D. re-opening of the foramen ovale

4. His condition predisposes him to infective endocarditis. One week later, he develops a fever and several septic emboli are detected in the lungs. Blood culture results reveal an organism that is alpha-hemolytic, catalase-negative, and optochin-resistant. Which pathogenic bacteria is the most likely cause of his sepsis?
   A. Streptococcus viridans
   B. Staphylococcus aureus
   C. Haemophilus influenzae
   D. Staphylococcus epidermidis

Case #6

PATIENT: age: 22; sex assigned at birth: male
The patient has a history of mild, fluctuating, unconjugated hyperbilirubinemia. Lab testresults indicate normal liver function. As there is no evidence of other disease processes, he is diagnosed with Gilbert syndrome.

1. What is the etiology of Gilbert syndrome?
   A. a genetic absence of uridine diphosphate glucuronosyltransferase
   B. a genetic decrease in hepatic levels of uridine diphosphate glucuronosyltransferase
   C. immature hepatic processing, causing deficient conjugation of bilirubin
   D. a deficiency of canalicular membrane transporters of bilirubin glucuronide

2. To make bilirubin more hydrophilic and facilitate its secretion into the biliary canaliculi, bilirubin is conjugated with _____.
   A. ascorbic acid
   B. hyaluronic acid
   C. glucuronic acid
   D. levomefolic acid

3. Bile drains directly from a bile canaliculus into a bile duct that is structurally parallel to a _____ in a portal triad.
   A. sinusoid
   B. cystic duct
   C. portal vein
   D. hepatic vein

4. Normally, bilirubin is _____ before it is excreted from the body via the kidneys.
   A. converted to biliverdin
   B. converted to stercobilin
   C. neutralized by uric acid
   D. converted to urobilinogen

Case #7

PATIENT: age: 57; sex assigned at birth: male
The patient has a routine physical examination, including lab tests. His lab test resultsindicate significant hypercholesterolemia.

1. He is prescribed a cholesterol-lowering statin drug. Statin drugs affect the rate-limiting enzyme used in the biosynthesis of cholesterol. What is this rate-limiting enzyme?
   A. lipoprotein lipase
   B. HMG CoA synthase
   C. HMG CoA reductase
   D. acetyl-CoA synthetase

2. When evaluating his lipid levels, the physician must differentiate between the different types of lipoproteins. What is the function of VLDL?
   A. transport of dietary lipids
   B. transport of cholesterol to the liver
   C. transport of triglycerides to the liver
   D. removal of triglycerides from the liver

3. Dietary cholesterol is transported to the liver as _____.
   A. LDL
   B. HDL
   C. VLDL
   D. chylomicrons

4. Hypercholesterolemia is a risk factor associated with the formation of atherosclerotic plaques. These plaques occur in which part of the vascular anatomy?
   A. tunica media
   B. tunica intima
   C. tunica externa
   D. tunica adventitia

5. An agent that binds with bile acids to form insoluble compounds in the digestive tract will _____ serum cholesterol levels, as _____.
   A. decrease; HMG-CoA reductase is inhibited
   B. increase; HMG-CoA synthase is stimulated
   C. increase; the liver synthesizes new bile acids from cholesterol
   D. decrease; the liver synthesizes new bile acids from cholesterol

Case #8

PATIENT: age: 50; sex assigned at birth: male
The patient presents with episodes of edema, shortness of breath, and uncontrolled hypertension.

1. Changes in blood pressure are sensed by baroreceptors in the carotid sinus. The carotid sinus is innervated primarily by the _____.
   A. facial nerve
   B. hypoglossal nerve
   C. glossopharyngeal nerve
   D. sympathetic chain ganglia

2. Ion channels play a key role in stabilizing blood pressure. What is the principle cation found in intracellular fluid, which is beneficial in the treatment of hypertension?
   A. zinc
   B. sodium
   C. calcium
   D. potassium

3. In addition to increasing sympathetic output and mineralocorticoid secretion, how does the renin-angiotensin-aldosterone system elevate systemic blood pressure?
   A. It increases blood volume.
   B. It decreases sodium retention.
   C. It decreases atrial natriuretic peptide.
   D. It causes direct systemic vasoconstriction.

4. When released from the vasa recta of the kidney, which protein initiates the angiotensin cascade?
   A. renin
   B. vasopressin
   C. angiotensin I
   D. angiotensinogen

Case # 9

PATIENT: age: 42; sex assigned at birth: male
The patient presents with chronic nausea, emesis, and upper abdominal pain. Lab test resultsindicate normal serum gastrin and a normal CBC. He is diagnosed with chronic gastritis caused by Helicobacter pylori.

1. A gastric biopsy would most likely reveal the presence of H. pylori and the presence of _____.
   A. normal rugal folds with multiple hemorrhagic erosions of the gastric mucosa
   B. intraepithelial neutrophils and subepithelial plasma cells of the stomach antrum
   C. enlarged rugae and hyperplasia of the mucosal epithelium, and no inflammation
   D. mucosal atrophy with lymphocytes and macrophages present in the stomach body and fundus, and loss of parietal cells

2. H. pylori is able to survive in the acidic environment of the stomach because the organism secretes _____, which neutralizes the acid.
   A. urease
   B. an exotoxin
   C. carbonic anhydrase
   D. a polysaccharide capsule

3. His impaired digestion is most likely due to reduced pepsin production. Pepsinogen is produced by which of the following cells?
   A. chief cells
   B. parietal cells
   C. glands of Brunner
   D. islets of Langerhans

4. In a patient who has gastritis, the mucosa and the lamina propria are affected. The lamina propria is histologically classified as _____.
   A. glandular epithelium
   B. simple columnar epithelium
   C. loose areolar connective tissue
   D. dense irregular connective tissue

5. Which one of the following agents stimulates gastric acid secretion?
   A. gastrin
   B. secretin
   C. pepsinogen
   D. cholecystokinin

Case #10

PATIENT: age: 68; sex assigned at birth: female
The patient presents with a 3-week history of acute low back pain. Radiologic studies showsevere osteoporosis and a compression fracture of L5.

1. A compression fracture of L5 results in impingement of the L5 spinal nerve as it exits the vertebral canal through the _____.
   A. vertebral foramen
   B. transverse foramen
   C. intervertebral foramen
   D. anterior sacral foramen

2. The pathogenesis of osteoporosis includes _____.
   A. decreased total bone mass
   B. increased osteoblastic activity
   C. decreased osteoclastic activity
   D. the accumulation of excess osteoid matrix

3. The absorption of _____, which occurs in the proximal small intestine, is made possible by _____.
   A. retinol; calcitriol
   B. calcium; calcitriol
   C. calcium; cholecalciferol
   D. cholecalciferol; hydroxylation reactions

4. The final biologically active metabolite of vitamin D requires several steps of conversion to take place in various tissues of the body. Conversion of D_3 to $25(OH)D_3$ occurs in the_____.
   A. skin
   B. liver
   C. brain
   D. kidney

5. This patient has an imbalance of bone deposition and reabsorption, which has resulted in decreased bone density. What is the principal mechanism calcitonin uses to influence bone density?
   A. decreased osteoblastic activity
   B. decreased osteoclastic activity
   C. increased release of calcium from transient pools
   D. increased reabsorption of calcium in the kidney tubules

Case # 11

PATIENT: age: 39; sex assigned at birth: female
The patient presents with numbness on one side of the face, weakness of the ipsilateral arm,and blurred vision. Physical examination reveals increased patellar and calcaneal deep tendon reflexes. Radiologic studies confirm a diagnosis of multiple sclerosis.

1. Multiple sclerosis is caused by a progressive destruction of which structures?
   A. neurons
   B. astrocytes
   C. Schwann cells
   D. myelin sheaths

2. Her condition is due to the activation of which immune cells?
   A. T cells
   B. B cells
   C. PMNs
   D. NK cells

3. As the multiple sclerosis progresses, CNS white matter begins to resemble gray matter histologically. This change is caused by the destruction of _____.
   A. ceramide and cerebroside
   B. sphingolipids and ceramide
   C. surfactants and sphingomyelin
   D. sphingolipids and phospholipids

4. What caused the increase in the deep tendon reflexes?
   A. increased cerebellar activity
   B. loss of antagonist muscle activity
   C. loss of upper motor neuron activity
   D. increased upper motor neuron activity

5. Which nerve innervates the calcaneal tendon?
   A. sural
   B. tibial
   C. femoral
   D. deep fibular

Case #12

PATIENT: age: 1 week; sex assigned at birth: female
The patient is diagnosed with phenylketonuria (PKU).

1. In the pathogenesis of PKU, _____cannot be converted into_____.
   A. serine; phenylalanine
   B. phenylalanine; serine
   C. tyrosine; phenylalanine
   D. phenylalanine; tyrosine

2. What is the inheritance pattern of PKU?
   A. x-linked recessive
   B. x-linked dominant
   C. autosomal recessive
   D. autosomal dominant

3. PKU is associated with inadequate activity of which enzyme?
   A. phenylalanine anhydrase
   B. phenylalanine hydroxylase
   C. 3-ketoacyl-CoA transferase
   D. phenylalanine dehydrogenase

4. The child has a musty odor. What is the most likely cause?
   A. accumulation of serum ammonia levels
   B. accumulation of metabolites of methionine
   C. inadequate breakdown of phenylacetic acid
   D. increased action of phenylalanine hydroxylase

Case #13

PATIENT: age: 16; sex assigned at birth: male
The patient has a history of intravenous drug abuse presents with fever, productive cough, and chest pain. Physical examination reveals tachypnea and central cyanosis. Lab test resultsindicate neutropenia. Radiologic studies confirm a diagnosis of bacterial bronchopneumonia.

1. In the lung of a patient who has bacterial bronchopneumonia, which morphologic changes are most likely to be present?
   A. total lobar fibrinosuppurative consolidation
   B. inflammatory changes confined within edematous alveolar septa
   C. inflammatory changes in the alveoli with the presence of hyaline membranes
   D. patchy consolidated areas of acute suppurative inflammation in one or more lobes

2. His inflammatory reaction to the infection was initiated in response to components of the infectious organism's cell wall. These cell wall components directly stimulate _____.
   A. proliferation of NK cells
   B. activation of complement
   C. differentiation of T_H17 cells
   D. production of IgE antibodies

3. Streptococcus pneumoniae is identified as the causative organism. S. Pneumoniae is a(n) _____ organism that is _____.
   A. aerobic; gram positive
   B. aerobic; gram negative
   C. facultative anaerobic; gram positive
   D. facultative anaerobic; gram negative

4. As a potential sequela to his condition, respiratory acidosis is most likely to occur if he _____.
   A. is anemic
   B. is vomiting
   C. has hypokalemia
   D. has fluid accumulation in the alveoli

Case #14

PATIENT: age: 20; sex assigned at birth: male
The patient presents with fever, hemoptysis, and hematuria. He has a recent history of a viral-like illness, which preceded the presenting symptoms. Lab test results confirm a diagnosis of Goodpasture syndrome.

1. In a patient who has this condition, which pathological change is most likely to occur?
   A. IgA deposition in the mesangium
   B. immune-complex deposition on both sides of the basement membrane
   C. anti-GBM (glomerular basement membrane) antibody deposition in the glomerular basement membrane
   D. loss of foot processes without morphological changes in the glomeruli

2. GFR is influenced by the integrity of the glomerular filtration barrier. This barrier is composed of the basal lamina, situated between a layer of _____ and a layer of _____.
   A. mesangial cells; podocytes
   B. mesangial cells; simple cuboidal epithelium
   C. glomerular capillary endothelium; podocytes
   D. glomerular capillary endothelium; simple cuboidal epithelium

3. The basal lamina is composed of three proteins: laminin, entactin, and _____.
   A. keratin
   B. albumin
   C. globulin
   D. type IV collagen

4. In a patient who has this condition, decreased GFR will cause compensatory changes in the renal tubules. To achieve this compensation in the renal tubule, which Starling force would be altered, and in which direction?
   A. tubular osmotic pressure would decrease
   B. interstitial osmotic pressure would increase
   C. tubular hydrostatic pressure would decrease
   D. interstitial hydrostatic pressure would increase

Case #15

PATIENT: age: 50; sex assigned at birth: male
The patient has a 5-year history of autosomal dominant polycystic kidney disease (ADPKD).He complains of a sudden, severe headache, and then rapidly loses consciousness. Lab test results reveal numerous RBCs in his cerebrospinal fluid. He is diagnosed with a subarachnoid hemorrhage.

1. To obtain a sample of CSF during a lumbar puncture, which layers, from superficial to deep, would a needle puncture?
   A. ligamentum flavum, dura mater, and arachnoid
   B. ligamentum flavum, annulus fibrosis, and dura mater
   C. dura mater, arachnoid, and posterior longitudinal ligament
   D. periosteum, ligamentum flavum, and posterior longitudinal ligament

2. His subarachnoid hemorrhage was most likely due to a rupture of weakened blood vessels. Which of the following would increase the tensile strength of collagen in the blood vessels by coupling hydroxyl groups with proline and lysine residues?
   A. zinc
   B. vitamin C
   C. vitamin K
   D. glucosamine

3. A patient who has this condition may experience vasospasm in reaction to the hemorrhage. Which mineral would be most useful in preventing vasospasm?
   A. sodium
   B. calcium
   C. potassium
   D. magnesium

4. The kidney responds to changes in systemic blood pressure by releasing variable amounts of renin. Which cells in which part of the kidney release renin?
   A. macula densa in the proximal tubule
   B. juxtaglomerular cells in Bowman's space
   C. macula densa in the distal convoluted tubule
   D. juxtaglomerular cells in the afferent arteriole

Case #16

PATIENT: age: 6; sex assigned at birth: male
The patient presents with muscle weakness and difficulty rising from a seated position. Physical examination reveals decreased muscle strength in the lower extremities, wasting in the pelvicmuscles, and mild hypertrophy of the calf muscles. He is diagnosed with muscular dystrophy (MD).

1. In this patient, which muscle protein is most likely aberrant or missing?
   A. actin
   B. myosin
   C. troponin
   D. dystrophin

2. Weakness in which muscle would most likely explain the difficulty rising from a seated position?
   A. rectus femoris
   B. gluteus medius
   C. gluteus maximus
   D. obturator externus

3. Which major regulatory proteins are found in muscle tissue and control normal muscle contraction?
   A. myosin and actin
   B. actin and troponin
   C. myosin and tropomyosin
   D. troponin and tropomyosin

4. Complement-activated membrane attack complexes (MAC complexes) have been observed in affected muscle cells of a patient who has MD. Formation of these MAC complexes is directly initiated when which active complement protein binds to the cell membrane?
   A. C1q
   B. C2b
   C. C3a
   D. C5b

ANSWERS TO QUESTIONS:

Case #1:	1. A	2. A	3. D	4. B	
Case #2:	1. D	2. B	3. C		
Case #3:	1. B	2. A	3. B		
Case #4:	1. A	2. A	3. D	4. B	
Case #5:	1. D	2. C	3. A	4. A	
Case #6:	1. B	2. C	3. C	4. D	
Case #7:	1. C	2. D	3. D	4. B	5. D
Case #8:	1. C	2. D	3. D	4. A	
Case #9:	1. B	2. A	3. A	4. C	5. A
Case #10:	1. C	2. A	3. B	4. B	5. B
Case #11:	1. D	2. A	3. D	4. C	5. B
Case #12:	1. D	2. C	3. B	4. C	
Case #13:	1. D	2. B	3. C	4. D	
Case #14:	1. C	2. C	3. D	4. C	
Case #15:	1. A	2. B	3. D	4. D	
Case #16:	1. D	2. C	3. D	4. D	