CANADIAN COLLEGE OF MICROBIOLOGISTS
SYLLABUS FOR EXAMINATION PREPARATION FOR REGISTRATION
(revised, 2013)

Introduction

The Canadian College of Microbiologists (CCM) provides a list of topics as a guideline for study in preparing for the Registered Microbiologist (RM) examination.
The guideline is extensive to accommodate applicants whose expertise has been in widely differing areas of microbiology. An analysis of past examinations shows the following distribution of questions according to subdisciplines:

1) General Knowledge of Microbiology 31%
2) Medical Bacteriology 21%
3) Applied (Food) Bacteriology 14%
4) Medical Virology 15%
5) Mycology 9%
6) Immunology 8%

The examination consists of two parts: Part A, worth 70%, is entirely multiple choices with questions in a variety of formats; Part B consists of essay questions where the candidate must choose 2 out of 6 prescribed topics on which to write two short 2 page essays, each worth 15%.

PART A (value 70% - multiple choice)

I. MEDICAL MICROBIOLOGY, IMMUNOLOGY AND INFECTIOUS DISEASES

1) IMMUNOLOGY
   - Lymphoid system and antibody
   - In vitro antibody interactions
   - B cells and monoclonal antibody
   - Complement
   - Phagocytic cells
   - Histocompatibility complex
   - Immediate hypersensitivity
   - Lymphocyte traffic and T-cells
   - Cell-mediated immunity
   - Lymphokines, IFNs, ILs, TNFs
   - Regulation of humoral immunity
   - Mucosal immunity
   - Mast cells

2) BASIC BACTERIOLOGY
   - Bacterial structure
   - Bacterial growth/metabolism
   - Bacterial toxins

- Bacterial genetics - mechanisms of gene transfer
- Sterilization and disinfection

3) MEDICAL BACTERIOLOGY
Mechanisms of pathogenicity: host parasite interactions

a) Gram-positive Cocci
   - Staphylococcus
   - Streptococcus

b) Gram-positive Rods
   - Mycobacterium
   - Corynebacterium, Listeria, Nocardia, Actinomyces and other Gram positive aerobes and facultative aerobes
   - Bacillus
   - Clostridium and other gram+ anaerobes

c) Enteric Gram-negative Rods
   - Escherichi coli
   - Salmonella, Klebsiella, Yersinia & Shigella
   - Vibrio & Aeromonas
   - Campylobacter and Helicobacter

d) Other Gram-negative Rods
   - Haemophilus
   - Pseudomonas and Legionella
   - Bordetella
   - Pasteurella, Brucella, Francisella

e) Gram-negative anaerobes

f) Gram-negative Cocci
   - Neisseria and Moraxella

g) Spirochaetes
   - Treponema
   - Borrelia
   - Leptospira

h) Wall-less Bacteria
   - Mycoplasma
   - Ureaplasma
   - L-forms

i) Obligate Intracellular Bacteria
   - Chlamydia, Chlamidiophila

- Rickettsiae

4) BASIC VIROLOGY
   - Nature & structure of viruses
   - Replication of viruses
   - Laboratory detection of viruses

5) MEDICAL VIROLOGY
   a) Herpes virus
      - Herpes/Varicella-Zoster
      - Cytomegalo/EB virus

   b) Hepatitis Viruses
      - Heptatitis A, B, C, D, E

   c) Papovaviruses and Poxviruses
      - Papilloma
      - Smallpox and other poxviruses

   d) Enterovirus
      - Picornaviruses

   e) Arboviruses.
      - Alphavirus (Western equine, Eastern equine encephalitis viruses)
      - Flavivirus (St. Louis encephalitis virus)
      - Bunyavirus (California encephalitis virus)
      - Yellow fever virus
      - Dengue virus
      - Ebola virus
      - Marburg virus

   f) Rhabdoviruse and SlowVirus Diseases-of the Central Nervous System
      - Rabies
      - Slow viral infections

   g) Gastroenteritis viruses
      - Reovirus
      - Coronavirus
      - Norwalk
      - Adenovirus

   h) Orthomyxoviruses & Paramyxoviruses
      - Influenza viruses
      - Parainfluenza virus
      - Measles virus
      - Respiratory Syncytial virus

- Mumps virus

i) Retroviruses
   - HTLV-1, 2
   - HIV-1, 2

j) Prion Diseases
   - Scrapie
   - Kuru
   - Bovine spongiform encephalopathy ("Mad Cow" disease)
   - Creutzfeldt-Jakob disease (CJD)

6) MEDICAL MYCOLOGY
   - Superficial, cutaneous, and subcutaneous mycoses
   - Systemic (Deep) mycoses
   - Opportunistic mycoses (Candida and others)

7) MEDICAL PARASITOLOGY
   - Entamoeba, Giardia,, Cryptosporidium, Balantidiurn
   - Trichomonas, Cyclospora
   - Toxoplasma, Pnemnoeystis
   - Plasmodium
   - Nematodes
   - Cestodes and trematodes

8) OTHER SUBJECTS

Some knowledge of the following aspects of infectious diseases is desirable:
   - Epidemiological aspects of infectious disease
   - Outbreak investigations
   - AIDS
   - Central nervous system infections
   - Sexually transmitted diseases
   - Gastrointestinal infections and food poisoning
   - Types of hypersensitivity
   - Immunity to virus infections
   - Humoral and phagocytic deficiencies
   - T-cell deficiency diseases
   - Secondary immune deficiency
   - Anaphylaxis and immunotherapy
   - Urticaria and food allergy
   - Immune hemolysis
   - Pathologic mechanisms of autoimmunity
   - Organ-specific autoimmunity
   - Loss of tolerance
   - HLA and disease
   - Systemic Lupus Erythematosis

- Transplantation
- Immunization
- Immunosuppression

II. INDUSTRIAL AND &APPLIED MICROBIOLOGY

1) Factors affecting Life and Death of Microorganisms
   - Temperature
   - UV Irradiation
   - Water activity
   - pH
   - Oxidation/reduction
   - Organic acids
   - Curing salts
   - Antibiotics
   - Gases (e.g. MAP)
   - Packaging
   - Cleaning, Disinfection, Hygiene
   - Prevention of Post-Processing Abuse
   - Other Preservatives

2) Significance of Microorganisms
   - Indication
   - Food-borne disease bacteria
   - Food-borne viruses
   - Food-borne parasites
   - Food-borne microbial toxins
   - Other food-borne microorganisms

3) Methods of enumeration
   - SPC
   - Coliform
   - Pathogens (e.g., Staphylococcus aureus, Salmonella, Listeria)

4) Rapid Methods-in Microbiology
   - Concepts of probability and sampling
   - Procedures to investigate food-borne illnesses
   - Statistical methods for food quality management
   - HACCP

5) Microbial Technology
   - Starter cultures
   - Food/feed yeasts
   - Microbial insecticides
   - Vinegar fermentation
   - Enzyme production

- Alcohol production

6) Rapid Detection Methodologies
   - Monoclonal Antibodies
   - Fluorescent Ab staining
   - EIA
   - Immunohistologies
   - Immunomagnetic separation
   - PCR and other amplification techniques and applications thereof
   - Molecular typing techniques
   - PFGE
   - RFLP
   - GLC, HPLC
   - Reporter Phage

7) Microbiology of Air
8) Microbiology of domestic water and sewage
9) Soil microbiology (Microorganisms as geochemical agents)

III. BIOSAFETY

1) Principles of Biosafety
   - Individual protection and safety
   - Immunoprophylaxis
   - Surveillance
   - Classification of infectious agents
   - MSDS
   - WHMIS

2) Containment levels
   - Biosafety level criteria
   - Biological safety cabinets

3) Risk assessment

4) Transportation and packing

5) Importation and documentation

6) Disposal methods

PART B. ESSAY QUESTIONS (The following are given as examples and have been used on recent examinations)

WRITE BRIEFLY ON ANY TWO OF THE FOLLOWING QUESTIONS

Do not exceed two (2) pages (Value 15% each).

1) Serologic tests for syphilis still form a major part of a diagnostic immunology laboratory function. Discuss these tests in terms of sensitivity, specificity and customary usage.
2) Outline a protocol for the isolation and identification of aerobic streptococci.
3) Describe the basic differences between viruses and bacteria and show how these effects their laboratory identification.
4) Briefly describe the meaning of genetic engineering and discuss potential benefits and problems.
5) Discuss the significance of the presence of coliforms in foods.
6) List in succession the steps involved in the isolation of Salmonellae from foods and explain briefly the rationale for each step.

Canadian College of Microbiologists RM (CCM) PRACTICE EXAMINATION (This is only an example of the certification examination. It includes questions that have been asked in previous examinations. It is intended for study purposes only.)

Part A. Choose the single most correct answer

1) **An organism that uses glucose as an energy source is:**
    a) organolithotrophic
    b) photoorganotrophic
    c) chemolithotrophic
    d) chemoorganotrophic
    e) an organoautotroph

2) **Which of the following techniques yields a viable count?**
    a) most probable number
    b) direct microscopic count
    c) nitrogen deternination
    d) turbidometry
    e) dry weight determination

3) **3. 95% ethanol is used in the Gram stain:**
    a) as a mordant which causes Gram-positive bacteria to remain stained
    b) to extract safranin from gram positive bacteria
    c) to dissolve a crystal violet-iodine complex
    d) to decolorize gram negative bacteria
    e) to dissolve the lipoposaccharide complex in gram negative bacteria

4) **The respiratory chain of bacteria is located in the:**
    a) mitchondria
    b) cell membrane
    c) cell wall
    d) ribosomes
    e) cytoplasm

5) **Phage typing:**
    a) is a method for tracing phage infections
    b) is useful in epidemiology
    c) is based on the fact that phages have a very wide host range
    d) will not differentiate between two bacteria which have identical biochemical
    e) patterns
    f) is only useful with Gram positive bacteria

6) **Sodium thioglycollate is incorporated into nutrient media for the growth of which one of the following groups?**

a) aerobic bacteria
b) yeasts
c) anaerobic bacteria
d) halophilic bacteria
e) thermophilic bacteria

7) Bacteria which are designated as acid-fast:

a) exhibit the colour of the counter strain
b) owe their staining characteristics to a large capsule
c) have an accumulation of waxy materials in the cell wall
d) are coccus types which divide in one plane
e) lack cell walls

8) A facultative halophile:

a) can grow in the presence or absence of increased amounts of salt
b) requires 10% NaCl in its growth media
c) requires 7.5% NaCI in its growth media
d) is one whose growth is accelerated by but not dependent upon increased salt
e) concentrations
f) none of the above

9) When using a steam autoclave, it is necessary to monitor the sterilization process using Geobacillus (formerly *Bacillus stearothermophilus) e*ndospores

a) with each load
b) daily
c) weekly
d) monthly
e) never

10) Bacterial endotoxins are:

a) heat stable
b) lipopolysaccharide-protein complexes
c) excreted into the medium
d) both a) and b)
e) all of a), b) and c)

11) Antibodies are:

a) mostly albumins
b) surface structures of erythrocytes
c) produced constitutively
d) produced by macrophages that have ingested antigen
e) none of a), b), c) or d)

12) Immunoglobulin G differs from lgA in:

a) molecular weight
b) carbohydrate content
c) upon mild reduction, IgG breaks down to yield, finally 2 heavy chains and 2
d) light chains, but lgA does not break down into subunits as a result of reduction
e) of its disulphide linkages
f) both a) and b)
g) all of a), b) and c)

13) An artificial active immunity against tetanus may be conferred on an animal by:

a) injecting tetanus antibody into its blood stream
b) injecting large amounts of toxin
c) injecting alum
d) injecting antibiotics
e) injecting toxoid

14) Lactobacilli contribute to food production by:

a) altering flavour
b) enhancing nutritional value
c) retarding spoilage and reducing contamination
d) altering texture and appearance
e) all of the above

15) In terms of the development and selection of yeast strains for use in a brewery there are a number of parameters important as scale-up criteria including:

a) production of high levels of fusel oils, esters and organo–sulphur compounds
b) ethanol tolerance
c) consistent high cell viability
d) and b) above
e) and c) above

16) There are three basic tests to detect coliform bacteria in water "Presumptive", "Confirmed" and "Completed". The following apply to these tests except:

a) they are performed sequentially
b) they detect lactose fermentation by acid and gas production
c) they use the MPN method
d) they determine the dry cell weight of coliforms in the sample
e) they use EMB agar

17) The genus of bacteria gaining dominance during the storage of chilled fresh meat and ultimately responsible for spoilage under aerobic conditions is:

a) *Bacillus*
b) *Lactobacillus*
c) *Moraxella*

d) *Enterobacter*
e) *Pseudomonas*

18) Which of the following food groups is the most important vector of food-borne pathogens in Canada?

a) Dairy
b) Seafoods
c) Poultry
d) Red Meats
e) Baked Goods

19) Most psychrotrophic bacteria responsible for the spoilage of chilled foods will not grow at:

a) –2°C
b) 5°C
c) 5°C
d) 25°C
e) 37°C

20) Presence of faecal coliforms in pasteurized milk indicates:

a) post-pasteurization contamination
b) use of unsanitary processing equipment
c) inadequate pasteurization treatment
d) a and b
e) all of the above

21) The microbial spoilage of cheese stored at 5°C would most likely be.due to:

a) thermophilic microorganisms
b) halophilic microorganisms
c) psychrophilic microorganisms
d) mesophilic bacteria
e) autotrophic bacteria

22) Listeria infection is most frequently associated with consumption of:

a) **C**heese
b) Poultry
c) Eggs
d) Seafood
e) green vegetables

23) *Vibrio parahaemolyticus* gastroenteritis is most frequently associated with consumption of contaminated:

a) poultry

b) milk
c) eggs
d) seafood
e) cheese

24) Which of the following biological preparations contains viable attenuated organisms?

a) diphtheria antitoxin
b) tetanus antitoxin
c) old tuberculin
d) B.C.G. vaccine
e) both a & b

25) Food poisoning due to *Staphylococcus aur*eus is caused by:

a) endotoxin
b) neurotoxin
c) enterotoxin
d) invasiveness of the ingested bacteria
e) both a & b

26) A delicate film of spreading growth on a blood plate, incubated anaerobically, best describes the growth exhibited by:

a) *Clostridium tetani*
b) *Proteus mirabilis*
c) *Bacillus cereus*
d) *Clostridium botulinum*
e) *Morganella morganii*

27) For optimum haemolytic reactions, the medium used as a base for blood agar plates should be free from.

a) sodium chloride
b) peptones
c) glucose
d) phosphates
e) yeast extracts

28) Which of the following methods can best be used to sterilize a thermolabile substance such as serum?

a) tyndallisation
b) autoclaving
c) filtration
d) hot air oven
e) gaseous sterilization using ethylene oxide

29) All but one of the following organisms have been associated with urinary tract infections in humans. The exception is:

a) *Escherichia coli*
b) *Enterobacter aerogenes*
c) *Proteus mirabilis*
d) *Bacillus anthracis*
e) *Klebsiella pneumoniae*

30) Epidemic meningitis is most frequently caused by:

a) *Haemophilus influenzae*
b) *Staphylococcus aureus*
c) *Streptococcus pneumoniae*
d) *Neisseria meningitis*
e) *Escherichia coli*

31) The infection caused by *Coxiella burnetii* is an exception among the Rickettsiae in that:

a) the organism can be cultured on artificial media
b) the infection is often transmitted to humans without the aid of an arthropod vector and presents with respiratory manifestations
c) the organism is not sensitive to tetracycline
d) the causative organism does not divide by binary fission
e) a domestic animal is the reservoir for the organism

32) 32 *Streptococcus pneumoniae* can cause:

a) a meningitis
b) pneumoniaotitis media
c) conjunctivitis
d) all of the above

33) Bacterial endotoxin is:

a) usually found in the cell wall of Gram-positive bacteria
b) released only upon death of the bacterial cell
c) part of the cytoplasmic membrane in Gram-negative bacteria
d) lipid A
e) lipoteichoic acid

34) *Streptococcus pneumoniae* produces what type of hemolysis on blood agar?

a) Alpha
b) Gamma
c) Beta

d) Target
e) Greek

35) If you had to maintain the viability of a specimen containing Neisseria gonorrhoeae, what temperature would you select?

a) 4°C
b) 20°C
c) 28°C
d) 37°C
e) 42°C

36) Which of the following is not produced by Staphylococcus aureus?

a) Catalase
b) Hyaluronidase
c) Coagulase
d) Fibrinolysin
e) erythrogenic toxin

37) Corrosion of water pipes is caused by:

a) *Acidithiobacillus thiooxidans*
b) Slime-forming bacteria
c) *Acidithiobacillus ferrooxidans*
d) *Desulfovibrio desulfuricans*
e) Algae

38) The vegetative growth of a fungus is composed of thread-like filaments called:

a) Sporangia
b) Rhizoids
c) Roots
d) Hyphae
e) Blastospores

39) Yeasts are:

a) colonisers of some parts of the human body
b) Gram positive
c) sometimes filamentous
d) all of the above
e) both a and b

40) Media selective for the isolation of fungi may contain one or more of the following ingredients:

a) Chloramphenicol
b) Rose Bengal

c) Cycloheximide
d) both a and c
e) all of the above

41) *Amanita phalloides* and *Aspergillus flavus* are similar in that they both:

a) form fleshy fruiting bodies which may be ingested
b) produce potent toxins
c) cause allergic reactions in individuals exposed to airborne spores
d) may contaminate foods such as nuts or corn
e) all of the above

42) A causative agent of ringworm is:

a) *Trichophyton rubrun*
b) *Blastomyces dermatitidis*
c) *Candida albicans*
d) *Sporothrix schenckii*
e) *Xylohypha bantiana*

43) *Candida albicans* may be identified by the production of:

a) Chlamydospores and germ tubes
b) Arthroconidia and germ tubes
c) Blastospores and pseudohyphae
d) Microconidia and macroconidia
e) All of the above

44) The antifungal antibiotic amphotericin B primarily acts by:

a) inhibiting cellular transport mechanisms
b) disrupting cell membrane continuity
c) uncoupling ribosomal subunits
d) binding to DNA
e) all of the above

45) The arboviruses are defined as viruses capable of infecting certain:

a) vertebrates
b) mammals
c) mammals and vertebrates
d) birds
e) vertebrates and insects

46) Hemagglutination inhibition tests may be used diagnostically for all but.

a) measles virus
b) rubella virus
c) influenza virus

d) human papilloma virus
e) adenovirus

47) Which of the following viruses is not transmitted by respiratory secretions?

a) Influenza
b) Rubella
c) St. Louis encephalitis
d) Mumps
e) Rhinovirus

48) Which of the following viruses does not form intranuclear inclusion bodies?

a) **V**accinia
b) herpes simplex virus
c) cytomegalovirus
d) reovirus
e) varicella zoster virus

49) A statement that a patient has had a four-fold or greater rise in antibody titer to a particular viral antigen over a period of time means:

a) an infection has occurred in the past
b) an infection with that particular virus was in progress during that period of time
c) the disease can definitely be attributed to that particular virus
d) a secondary response has occurred
e) nothing, unless the type of antibody is known

50) Attenuated live virus vaccines have been employed for the control of:

a) Measles
b) Mumps
c) Rubella
d) variola major
e) all of the above

51) The reason that influenza occurs periodically in pandemics is largely due to which one of the following reasons:

a) its ability to be transmitted easily from person-to-person
b) its ability to resist inactivation when in droplet-nuclei in air
c) its ability to undergo the phenomenon known as "antigenic drift"
d) its ability to engender an immunity of only a year or less in its host
e) its ability to infect a variety of hosts and survive inter–epidemic periods

52) Phosphorylation is a process whereby:

a) substrate molecules are converted into ATP
b) the synthesis of macromolecules is coupled to the synthesis of ATP

c) ATP is synthesized
d) ATP is hydrolysed
e) the hydrolysis of ATP is coupled to the synthesis of macromolecules

53) Chemoheterotrophic metabolism involves:

a) the oxidation of organic molecules to produce energy and their use as a carbon source
b) the fixation of carbon dioxide as carbon and energy
c) the oxidation of chlorophyll for energy and fixation of carbon dioxide as a carbon source
d) the oxidation of chlorophyll to fix carbon dioxide
e) none of the above

54) All of the following affect the rate at which a population of microorganisms is killed except

a) population size
b) organism's susceptibility
c) time of exposure to the killing agent
d) concentration of the amtimicrobial
e) degree of hydration

55) Antigens:

a) are always proteins
b) induce the formation of antibodies
c) are not involved in allergic reactions
d) are immunoglobulins
e) none of the above

ANSWERS

1 d **13** e **25** c **37** c **49** e
2 a **14** e **26** a **38** d **50** e
3 c **15** e **27** d **39** e **51** c
4 e **16** d **28** c **40** e **52** c
5 b **17** a **29** d **41** b **53** a
6 c **18** c **30** d **42** a **54** a
7 c **19** e **31** b **43** a **55** b
8 d **20** e **32** e **44** b
9 c **21** c **33** d **45** e
10 d **22** a **34** a **46** d
11 e **23** d **35** b **47** c
12 e **24** d **36** e **48** d

Suggested reading:

Several microbiology textbooks are available. The following are 2 examples of the quality f textbook that is recommended.

Medical Microbiology, 2012. 7th Edition, by Dr. Patrick R. Murray, Dr. Ken S. Rosenthal, and Dr. Michael A. Pfaller

Microbiology: Principles and Explorations, 2012. 8th Edition by Jacquelyn G. Black

There are also a number of on-line texts available for downloading from the Web.