STUDY GUIDE

FOR

DIALYSIS TECHNOLOGY CERTIFICATION (CANADA)

Contents

Introduction

The purpose of this study guide is to help you in preparing for the national certification examination in Dialysis Technology. This guide, along with the suggested text resources, will assist you in reviewing critical concepts related to the Core Competencies in dialysis technical practice. These Core Competencies are included in the study guide for your review. It is from this document that the exam blueprint was created.

Your success on the examination will depend on your knowledge and skills in dialysis technical services and your ability to apply this knowledge and experience to the questions on the exam. The study guide will help you review core concepts and apply this to sample test questions. The guide also covers study skills and test taking strategies to help you be successful.

Certification is part of the professional's overall commitment to quality care for patients. As the role of the dialysis technologist/technician continues to expand, the need for certification will become increasingly important. We congratulate you on your decision to certify in your field of expertise and wish you every success in completion of the examination.

Every effort has been made to ensure accuracy throughout this guide. Unintentional errors/omissions are not the responsibility of the Canadian Board of Examiners for Biomedical Engineering and Dialysis Technologists and Technicians.

Further information on certification process and fees can be obtained from the website at:
http://bmetcertcanada.ncf.ca/

Enquiries can be directed to the Secretariat:

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CHAPTER 1
Role of the Agencies in Certification

The International Certification Commission (ICC) includes representation from various divisions of the health care industry – medical, engineering, manufacturing, government and agencies. The ICC supervises the certification of dialysis technicians/technologists under the umbrella of the Canadian Board of Examiners for Biomedical Engineering and Dialysis Technologists and Technicians. The Canadian Board of Examiners' role is to promote certification and to administer the national examination for both biomedical and dialysis technologists and technicians.

The dialysis technologist/technician plays an integral role in the care of patients with chronic kidney disease (CKD). They ensure that the equipment and methods used in dialysis treatment delivery are safe, effective and in accordance with accepted protocol. The dialysis technologist/technicianshares a common goal with other nephrology professionals – that is to provide quality care by working as part of a multi-disciplinary team. To this end, the dialysis technologist/technician has a responsibility to remain current and competent in accordance with the CANNT Standards for Nephrology Technical Practice. The CANNT Standards of Technical Practice were developed by the technical membership in consultation with the CANNT Board of Directors. These standards undergo scrutiny on a regular basis to ensure currency and relevancy.

Underpinning the practical aspects of the exam preparation was a significant financial bequest from Fresenius Medical Care Canada. Subsequent to their donation, the work of the Steering Committee was made easier, knowing that the cost of exam development would not be passed on to the candidate writing the exam.

The certification process is voluntary and is intended to validate the specialized body of knowledge in the field of dialysis technology. By creating national standards in the technical field, dialysis technicians and technologists can earn the credential, Certified Dialysis Technologist/Technician (cdt), which is licensed for use through the Canadian Board of Examiners for Biomedical Engineering and Dialysis Technology Certification Program.

Canadian Dialysis Technology Certification Program

Included in this Study Guide are the program information, application procedure, eligibility requirements, fees and exam format for either a Technologist or a Technician, and an application form. The procedure is as follows:

1. Upon receipt of a completed application form and fee, you will receive a receipt for your payment, which will indicate that your file has been activated.

2. The Secretariat will send out reference requests to the people indicated on your form.

3. Upon receipt of these completed references, your file is directed to the Board of Examiners for review. The Board will determine if you meet the requirements for examination, or if additional information, or further study is required.

4. When the Secretariat has been advised of your acceptance for examination, a proctor will be appointed to oversee the written examination. The proctor will be a qualified examiner in your city/town, or as close as possible.

5. You will be given 3 hours to complete the examination, the format of which is detailed later in this Study Guide. The use of hand-held scientific calculator (no calculators that allow text storage or formulation(s) is permitted. No electronic communication devices will be allowed in the examination room.

6. Upon successful completion of the written examination, the Board will advise you of your results. The Board then makes its recommendation to the International Certification Commission, and a Certificate will be issued.

7. If you have not achieved a passing mark on the written exam, you will be advised. The pass mark for this examination is 70%. You can rewrite the examination at a later date for a nominal re-write fee. The second exam will be different than the first.

8. On successful completion, your Certificate is sent to the Canadian Board Chairman for signature and then to the address you indicate in your application.

9. An annual renewal fee is implemented to maintain the Canadian Certification process and provides your listing to the International Certification Commission Directory of Certified Individuals.

Re-Certification

Certification is valid for five years. During this time, the candidate must accrue 75 Continuing Education Unit (CEU) hours in order to re-certify. CEU credits can be obtained through attendance at conference keynote or concurrent sessions, manufacturer's training days, in-house education seminars or through completion of self-study units available in professional dialysis journals. Candidates keep a portfolio of their CEU credits for evaluation by the Certification Team.

CHAPTER 2
Examination Development

The certification examination has been created by a team of senior technologists, industry representatives and educators. The team members represent all regions of Canada making this is a truly national project.

Once questions are submitted, they undergo a review by an independent group to assess the quality of the questions and their compliance with the Core Competencies and Exam Blueprint. References for the correct answer(s) are checked and there is an assessment of cultural sensitivity factors to ensure that the exam is free from cultural bias. The examination is constructed yearly using questions that have validated well statistically in past writings. The exam will consist of approximately 100 – 125 questions. Questions are assigned a point value (one, two or three points) based on their degree of difficulty. The pass mark is 70%. The certification exam is written in English.

After the examination is written, statistical analysis takes place in the questions for measures of validity and reliability. Questions that do not validate well can be removed or revised for future use. A continuous intake of questions is essential for the examination to represent the most current technology used in the dialysis field. The intent of the development cycle is to ensure that the examination is fair and that it represents the current requirements of technical practice.

CHAPTER 3
Core Competencies

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Introduction

In accordance with the current Canadian Standards for Nephrology Technical Practice, (revised 2003), the following core competencies have been ratified by technical members of CANNT. These competencies include the knowledge, skills and critical judgments required by nephrology technologists to practise professionally. These represent the current expectations of the field and will be revised on a regular basis to reflect changes in the field.

The core competencies also act as a basis for the development of the examination blueprint for the certification examination. While this process is voluntary, it is hoped that that all technical members will certify themselves using the process available through the provincial engineering technology associations.

The role of the technologist/technician in current technical practice is one that combines technical, scientific and clinical knowledge in utilizing and modifying the technology so that the long-term outcomes of the patient are optimized and complications reduced.

Critical Competencies

1. Water Treatment for Dialysis

a) need for water purification in dialysis
b) classification of potable water contaminants
c) evaluation of feed water quality
d) system components: purpose, method of operation, rationale for specific location in the system, maintenance, testing and troubleshooting for the following
   i. particle/depth filtration
   ii. carbon filtration
   iii. water softener
   iv. deionisation
   v. reverse osmosis
   vi. UV irradiation
   vii. ultra filters at point of use
e) distribution systems: importance of system configuration (direct vs indirect feed loops), piping layout to improve water velocity and decrease dead lags, selection of materials, methods of installation, calculation of velocity required
f) disinfection and cleaning: agents used, concentrations and contact times required for effective disinfection, rinsing protocols, testing for residual and reason for testing
g) water quality monitoring
   i. chemical (ph, conductivity, resistivity, total hardness, free and total chlorine, iron)
   ii. physical (% rejection and % recovery, silt density index, empty bed contact time, pressures)
   iii. microbiological (bacterial and endotoxin testing)

2. Dialysis Membrane Technology

a) principles of permeability and containment of cellular components in blood
b) membrane materials: cellulose based (modified and unmodified), synthetic materials (PS, PA, PAN, PMMA etc.)
c) manufacturing technologies: melt spinning, solution spinning
d) definition of clearance and dialysance, differences invitro and invivo
e) influencing factors: temperature, pressure, pore size, convective transport
f) dialyser designs: plate and hollow fibre
g) dialyser flow dynamics: co-current vs counter-current flow
h) requirements on housing and potting material
i) bio-compatibility of dialyser membranes, thrombogenicity, complement activation, first use syndrome, cytokine release
j) methods of sterilization and impact on thrombogenicity

3. Dialysis Membrane Re-processing

a) high level disinfection vs sterilisation methods: heat/citric acid, peracetic acid/hydrogen peroxide/acetic acid, formaldehyde, sodium hypochlorite
b) types of systems used: automated vs manual systems: applications and limitations
c) processes related to re-processing cycle: rinsing, reverse UF, cleaning, testing dialyser performance (pressure testing, fibre bundle volume, in vitro Kuf), disinfection/sterilisation, storage, testing for presence, testing for residual after rinsing, patient identification
d) CQI (continuous quality improvement) and QA (quality assurance) management: risk management strategies, statistical analysis of incidents, documentation and reporting
e) safety of public and hospital personnel: exposure to chemical agents
f) physical plant considerations: RO water supply, testing RO water for contamination, endotoxin testing, air exchange, holding tanks, physical layout of re-processing unit
g) bio-compatibility of sterilisation methods, symptoms related to bio-incompatibility

4. Basic Principles of Dialysis: Processes across membranes

a) fluid compartments in the body: intracellular, intravascular, interstitial
b) Diffusion: diffusion coefficient (in free solution and across a membrane) resistance of surface layers, influence of molecular weight, membrane thickness, pore size distribution, membrane area, KoA, clearance of water soluble vs fat soluble molecules
c) Filtration: pressure/filtrate flow relation, sieving coefficient and flux
d) Osmosis
e) Ultrafiltration: definition of ultrafiltration
f) electrical charge
g) hi-flux and lo-flux dialysers (definition, brief explanation)

h) concentration of small (urea, creatinine, urate), middle (B12, LMW heparin, heparin, insulin) and large molecules (myoglobin, albumin, hemoglobin, cytochrome C) in blood

i) Absolute cut-off for molecules: 10,000 Daltons (lo- flux dialyses) and 80,000 Daltons (hi-flux dialyses)

5. Haemodialysis System Components

I. Extra-corporeal blood circuit:

a) thrombogenicity of different materials, sterilization of blood lines

b) protective filters: transducer protector

c) safety devices: air detector, clamps

d) infusion pumps (ie. heparin): calculation of infusion rates, mathematical conversion between ml/hour and IU/hour

e) blood pumps: types (occlusive, non-occlusive)

f) blood pump problems: haemolysis, pressure conditions, turbulence related to excess flow, measure of actual vs indicated blood flow

g) special applications: neonatal and paediatric

II. Concentrates for haemodialysis and haemofiltration:

a) acetate, lactate and bicarbonate buffered concentrates

b) acid concentrate

c) other electrolytes currently used

d) dry concentrates: dilution ratios

e) bacteriostatic properties

f) devices for reconstitution of concentrates & delivery systems

g) individualized dialysate prescriptions and batch systems

III. Haemodialysis Machine Hydraulic Systems:

a) UF Control systems: balancing chambers vs flow sensors

b) Dialysate delivery systems design: volumetric systems, conductometric (servo) feed-back systems

c) Motors, pumps, valves, regulators, deaeration devices and relief valves: purpose, location, maintenance, troubleshooting and repair

d) Probes and sensors: temperature, conductivity, pH, and ultrafiltration (UF), arterial and venous pressure monitoring systems - purpose, location, maintenance, troubleshooting and repair

e) Flow equalizers, heaters, heat exchangers and end-stroke-sensors, back siphon protection: purpose, location, maintenance, troubleshooting and repair

f) Bypass function: purpose, criteria for activation, calibration for safety

g) UF measurement: ultrafiltration rate, transmembrane pressure, ultrafiltration characteristics, impact of plasma proteins, pressure conditions along a dialyser, ultrafiltration measurement principles (closed circuit - intermittent, continuous) reverse ultrafiltration

h) Dialysate solutions: conductivity, temperature, precipitation risks and remedies, pH monitoring, safety mechanisms for detection of wrong concentrates
i) Hydraulic Troubleshooting: principles of problem identification, typical remedies, retesting, documentation of repairs
j) Specialized Systems: Sorbent dialysis systems
k) Cleaning & sanitization of hydraulic components

6. Dialysis Electrical and Electronic Systems

a) power distribution: AC, DC, 120V, 5V, 12V and 24V devices - location and rationale for each type of device in dialysis systems
b) principles of electrical safety: ground fault interruption
c) principles of operation of sensory and control devices
d) principles of operation of sensory and control devices
e) principles of operation of sensory and control devices
f) principles of electronic troubleshooting
g) principles of electronic troubleshooting
h) proper handling of static sensitive devices: PCBs, integrated circuits etc.
i) interference by radio emitting devices, ie., cell phones
j) line isolation

7. Computer Systems in Dialysis

a) standards and software protocols
b) input devices, output devices
c) local area networks (LANs) and wide area networks (WANs)
d) dialysis specific software options: renal data management packages, treatment data base
e) criteria for purchasing decisions: type of PC, operating system, CPU, memory, use of expansion slots and COM/LPT ports
f) software implementation strategies

8. Hemodialysis On-line technologies

a) continuous blood volume monitoring , including automated UF control
b) access flow and recirculation measurements
c) blood temperature and thermal balance monitoring and control
d) ionic dialysance
e) urea concentration and dialysis dose monitoring
f) total pool dialysate collection - aliquot method

9. Safety Standards and Directives

a) overview of standards organisations and scope of their activities (CSA, AAMI, IEEC, TUN, etc.)
b) overview of government/health standards agencies (HPB/TPP) knowledge of DIN numbers, procedure for reporting patient side effects to HPB

c) electrical installation (home and in-centre) and use of electricity in patient care areas
d) water treatment for dialysis
e) dialysers and haemofilters
f) re-processing of dialysers
g) Medical equipment risk classification system
h) norms and regulations on waste disposal
i) specialised guidelines for dialysis: CSN (Canadian Society of Nephrologists), DOQI (Dialysis Outcomes Quality Initiative)
j) Workplace Hazardous Materials Information System (WHMIS)
k) universal precautions
l) quality assurance of calibration equipment
m) reference individual standards

Supportive Competencies

1. Renal Anatomy/Physiology & Pathology

a) structure of the nephron - location, blood supply, nerve supply, structures
b) function of kidneys: excretion/secretion, acid-base regulation, electrolyte balance, fluid balance, blood pressure regulation, endocrine functions (Vitamin D synthesis, erythropoietin secretion, production of renal prostaglandins)
c) assessment of kidney function: biochemical and morphological tests
d) overview of commonly used medical terminology
e) overview of renal failure

i. **acute:** description, causes (based on location of etiological event - pre-renal, renal and post-renal), stages (initiating, oliguric, diuretic and recovery), typical course of the disease, goals of treatment

ii. **chronic:** description, causes (congenital disorders, cystic disorders, tubular disorders, neoplasms, infectious diseases, obstructions and chronic systemic diseases), stages (stage I decreased renal reserve, stage II renal insufficiency, stage III chronic renal failure), typical course of the disease, goals of treatment

2. Treatment Modalities

a) **Haemodialysis:** indications for treatment, overview of types (in-centre HD, nocturnal and home hemodialysis, self-setup dialysis centers, routine vs single needle dialysis, paediatric dialysis and complications of all treatment types
b) **Peritoneal Dialysis:** indications for treatment, function of the peritoneal membrane, access, complications related to treatment, types of treatment (CAPD, CCPD, IPD) types of cyclers, types of solutions
c) **Renal Replacement Therapies:** Haemofiltration, Haemodiafiltration, Haemoperfusion (in conjunction with other therapies): differences from HD in configuration of blood and dialysate/substitution fluid circuits, bag and on-line systems with pre and post dilution, fluid balance control systems, warming systems for substitution fluids, use of anticoagulation (monitoring activated clotting time - ACT), slow

continuous ultrafiltration (SCUF), continuous arterio-venous hemofiltration (CAVH), continuous veno-venous hemofiltration (CVVH), continuous veno-venous hemodiafiltration (CVVHD) - principles of operation, indications for use, type of membrane used

d) **Renal Transplantation**: indications for transplantation, types of transplant, criteria for recipient selection, care of donor organ, complications of treatment

e) **Renal Therapeutic Nutrition:** requirements/restrictions for protein, carbohydrates, fats, fluids, vitamins, minerals (Ca, Phosphorus, Potassium etc) assessment of protein catabolic rate (PCR)

3. Assessment of Dialysis Adequacy

a) **Mathematical models of dialysis adequacy:** (including but not limited to) For Haemodialysis: Dialysis Index, Urea Kinetic Modelling, standard KT/V, PRU (percentage reduction of urea) equivalent renal clearance. For Hem filtration: PCR, clearance and exchanged volume in post- and pre-dilution mode in terms of SC, KT/V, QS/QB, For PD: PET (peritoneal equilibration test)

b) **compartment models and their use in RRT:** Basics of compartment model mathematics (open and closed compartment systems), single-pool and multiple-pool kinetic models, first-order kinetics, differences for protein bound substances, regional flow models

c) **methods and devices for measuring adequacy of dialysis:** urea enzyme methods, Na substitution method for urea, aliquot method for pool dialysate collection

4. Access assessment techniques and technologies

a) **types of access:** fistula, vascular graft, catheters, other access devices

b) **evaluation of blood flow** through vascular access (Doppler techniques, blood flow dilution techniques)

c) **recirculation measurement** (concentration and dilution techniques), evaluation of pressures

d) **impact of recirculation** on dialysis efficiency (including cardiopulomary recirculation theory)

5. Anticoagulation & coagulometric technologies

a) review of coagulation cascade

b) theory of anticoagulation: indications, risks, methods of anticoagulation (systemic, extracorporeal heparinization, no heparinization - NS flushes)

c) types of anticoagulants: heparin, low molecular weight heparin, citrate, coumadin

d) interpretation of coagulation times: PT, PTT, INH, ACT (activated clotting time)

e) principles of coagulometers, including programmable meters evaluating anticoagulant kinetic

6. Complications of Haemodialysis Treatment

a) complications related to the extra corporeal circuit: air embolism, blood leak, exsanguination
b) complications related to the dialysate: haemolysis, crenation
c) complications related to the dialyser: type 1 and 2 reactions
d) complications related to the access: thrombosis, stenosis, steal syndrome, aneurysm/ pseudo-aneurysm, access re-circulation, needle infiltration, access infection
e) complications related to the patient: hyper/hypotension, cramps, nausea/vomiting, headache, chest and back pain, febrile reactions, pruritus, dialysis disequilibrium syndrome, arrhythmias, cardiac tamponade/pericarditis/arrest, hypoxemia, stroke
f) complications related to long term exposure to low level contaminants and chemicals used in dialysis treatment

7. Applied Chemistry

a) basic principles: ions and molecules, principles related to pH, molecular weight, calculations
b) application of principles of conductivity to dialysate solution: analysis of solutions pre-treatment and safety considerations
c) molecular structure and function of bio-molecules in blood: sugars, mobile fats, electrolytes, amino acids, blood proteins, hormones, enzymes and immunoglobulins
d) normal electrolyte levels, serum values of metabolic wastes in ESRD

8. Applied Microbiology

a) chain of infection
b) pathogens in the dialysis environment: common and multiply resistant organisms, characteristics of the organism
c) symptoms of infection: local and systemic
d) methods to control spread of infection by hospital personnel
e) aseptic technique
f) category specific and disease specific isolation
g) universal precautions
h) controlling contaminations to dialysis equipment & water treatment system

9. Professional Practice

a. criteria for professional practice: professional credibility, due diligence, self regulation, advanced knowledge, on-going education
b. confidentiality and consent
c. professional self regulation: responsibilities for reporting incompetence or malpractice
d. roles of professional associations: provincial/national engineering technology associations, Canadian Association of Nephrology Nurses and Technologists
e. Standards of Technical Practice for CANNT
f. Cultural Sensitivity

CHAPTER 4
Examination Blueprint

EXAMINATION FOCUS

The primary function of the examination blueprint for the Dialysis Technology Certification Examination is to describe how the examination will be developed related to the Core Competencies. The blueprint also provides a guideline for item writers on how the competencies will be evaluated and at what level of the educational taxonomy the exam questions will be written, ie., Knowledge, Application and Critical Thinking.

COMPETENCY GROUPS AND WEIGHTINGS

To ensure that the examination accurately reflects the profile of dialysis technical practice, the competencies were divided into those that are "critical" and those that are "supportive" to job performance. Part 1 consists of "critical" competencies and Part 2 consists of "supportive" competencies. Feedback from practicing technologists was solicited to create a system for establishing relative importance of each.

The **critical** competencies are:

1. Water Treatment for Dialysis
2. Dialysis Membrane Technology
3. Dialysis Membrane Re-processing
4. Basic Principles of Dialysis
5. Hemodialysis Systems Components
6. Dialysis Electrical and Electronic Systems
7. Computer Systems
8. Hemodialysis On-line Technologies
9. Safety Standards and Directives

The **supportive** competencies are:

1. Renal anatomy/physiology & pathology
2. Treatment modalities
3. Assessment of Dialysis Adequacy
4. Access Assessment Techniques and Technologies
5. Anticoagulation & Coagulometric Technologies
6. Complications of Hemodialysis Treatment
7. Applied Chemistry
8. Applied Microbiology
9. Professional Practice

Weighting of Questions

Approximately 60% of total questions will be taken from the critical competencies and approximately 40% from the supportive competencies. Depending on the level of difficulty, questions will be weighted at one, two or three points respectively for an increasing level of difficulty in the educational taxonomy.

LEVEL OF DIFFICULTY

Questions will be written at three levels of difficulty: knowledge/comprehension, application and critical thinking. These levels are adapted from the Taxonomy of Cognitive Abilities originally developed by Bloom (1956).

a) **Knowledge/Comprehension:** This level of questioning combines the ability to recall previously learned material and to understand its meaning. Typical questions relate to recalling and understanding facts, principles and interpreting data. This type of question will be worth one point. This type of question is identified as “K” in the examination blueprint.

b) **Application:** This level of questioning requires use of existing knowledge in new situations. The outcome demonstrates use of practical problem solving. This type of question will be worth two points. This type of question is identified as “A” in the examination blueprint.

c) **Critical Thinking:** This level of questioning includes the ability to judge the relevance of information/data, to identify priorities, to formulate valid conclusions, to identify cause-effect relationships and to solve complex problems based on multiple factors. This type of questions will be worth three points. This type of question is identified as “CT” in the examination blueprint.

For the purpose of this examination, the following distribution of questions across these levels will be as follows:

Cognitive Level	% of Questions
Knowledge/comprehension	15 - 25%
Application	50 - 60%
Critical Thinking	20 - 30%

Part 1
Critical Competencies

Competency: **Water Treatment for Dialysis**	**Level of Questions**
a) Need for water treatment in dialysis	**A**
b) Classification of potable water contaminants	**K**
c) Evaluation of feed water quality	**CT**
d) System components: purpose, method of operation, rationale for specific location in the system, maintenance, testing and trouble-shooting of the following: particle/depth filtration carbon filtration water softener deionisation reverse osmosis UV irradiation ultra filters at point of use	**A**
e) Disinfection and cleaning: agents used concentrations and contact times required for effective dis-infection rinsing protocols, testing for residual and reason for testing	**A**
f) Water quality monitoring: chemical: ph, conductivity, resistivity, total hardness, free and total chlorine, iron physical: % rejection and % recovery, silt density index, empty bed contact time, pressure testing microbiological: bacterial and endotoxin testing	**A**

Competency: **Dialysis Membrane Technology**	**Level o Questions**
a) Principles of permeability and containment of cellular components in blood	**K**
b) Membrane Materials: cellulose based (modified and unmodified), synthetic (PS, PA, PAN, PMMA, etc.)	**K**
c) Manufacturing Technologies: melt spinning, solution spinning	**K**
d) Definition of Clearance and dialysance, differences invitro and invivo	**K**
e) Influencing factors: temperature, pressure, pore size, convective transport	**K**
f) Dialyser designs: plate and hollow fibre	**K**
g) Dialyser flow dynamics: co-current and counter-current flow	**K**
h) Requirements for housing and potting material	**K**
i) Bio-compatibility of dialyser membranes: thrombogenicity, complement activation, first use syndrome, cytokine release	**A**
j) Methods of sterilization and impact on thrombogenicity	**A**

Dialysis Membrane Re-processing	**Level of Questions**
a) High level disinfection vs sterilisation methods: i. heat/citric acid ii. peracetic acid/hydrogen peroxide/acetic acid iii. formaldehyde iv. sodium hypochlorite	**A**
b) Types of systems used: i. automated vs manual systems ii. applications and limitations	**A**

c) Processes related to re-processing cycle: i. Rinsing ii. reverse UF iii. cleaning iv. testing dialyser performance (pressure testing, fibre bundle volume, in vitro Kuf) v. disinfection/sterilisation vi. storage vii. testing for presence viii. testing for residual after rinsing ix. patient identification	**A**
d) CQI (continuous quality improvement) and QA (quality assurance) management: i. risk management strategies ii. statistical analysis of incidents iii. documentation and reporting	**CT**
e) Safety of public and hospital personnel: i. exposure to chemical agents	**A**
f) Physical plant considerations: i. RO water supply ii. testing RO water for contamination iii. endotoxin testing iv. air exchange v. holding tanks vi. physical layout of re-processing unit	**A**
g) Bio-compatibility of sterilisation methods: i. symptoms related to bio-incompatibility	**CT**
h) Potential risks related to use of re-processed dialysers	**CT**

Competency: Basic Principles of Dialysis: Processes Across Membranes	**Level of Questions**
a) Fluid compartments in the body: i. Intracellular ii. Intra-vascular iii. Interstitial	**K**

b) Diffusion: i. diffusion coefficient (in free solution and across a membrane) ii. resistance of surface layers iii. influence of molecular weight iv. membrane thickness v. pore size distribution vi. membrane area vii. KoA viii. clearance of water soluble vs fat soluble molecules	**A**
c) Filtration: i. pressure/filtrate flow relation, ii. sieving coefficient and flux	**K**
d) Osmosis	**K**
e) Ultrafiltration: definition of ultrafiltration	**K**
f) Electrical charge	**K**
g) Hi-flux and lo-flux dialysers (definition, brief explanation)	**K**
h) Concentration of Molecules: I. small (urea, creatinine, urate) II. middle (B12, LMW heparin, heparin, insulin) III. large molecules (myoglobin, albumin, haemoglobin, cytochrome C)	**A**
i) Absolute cut-off for molecules: I. 10,000 Daltons (lo- flux dialysers) II. 80,000 Daltons (hi-flux dialysers)	**K**

Competency: Haemodialysis System Components	**Level of Questions**
I. Extra-corporeal blood circuit: a. thrombogenicity of different types of materials, sterilization of blood lines b. protective filters: transducer protector c. safety devices: air detector, clamps d. infusion pumps (ie. heparin): calculation of infusion rates, mathematical conversion between ml/hour and IU/hour, e. blood pumps: types (occlusive, non-occlusive) f. blood pump problems: haemolysis, pressure conditions, turbulence related to excess flow, measure of actual vs indicated blood flow g. special applications: neonatal and paediatric	**A**
II. Concentrates for Haemodialysis and haemofiltration: a) acetate, lactate and bicarbonate buffered concentrates b) acid concentrate c) other electrolytes currently used d) dry concentrates: dilution ratios e) bacteriostatic properties f) devices for reconstitution of concentrates & delivery systems g) individualized dialysate prescriptions and batch systems	**A**
III. Haemodialysis Machine Hydraulic Systems a) UF Control systems: balancing chambers vs flow sensors b) Dialysate delivery systems design: volumetric systems, conductometric (servo) feed-back systems c) Motors, pumps, valves, regulators, deaeration devices and relief valves: purpose, location, maintenance, troubleshooting and repair d) Probes and sensors: temperature, conductivity, pH, and ultrafiltration (UF), arterial and venous pressure monitoring systems - purpose, location, maintenance, troubleshooting and repair e) Flow equalizers, heaters, heat exchangers and end-stroke-sensors, back siphon protection: purpose, location, maintenance, troubleshooting and repair f) Bypass function: purpose, criteria for activation, calibration for safety g) UF measurement: ultrafiltration rate, transmembrane pressure, ultrafiltration characteristics, impact of plasma proteins, pressure conditions along a dialyser, ultrafiltration measurement principles (closed circuit - intermittent, continuous) reverse ultrafiltration h) Dialysate solutions: conductivity, temperature, precipitation	**A**

risks and remedies, pH monitoring, safety mechanisms for detection of wrong concentrates i) Hydraulic Troubleshooting: principles of problem identification, typical remedies, retesting, documentation of repairs j) Specialized Systems: Sorbent dialysis systems k) Cleaning & sanitization of hydraulic components	

Competency: Dialysis Electrical and Electronic Systems	**Level of Questions**
a) Power distribution: AC, DC, 120V, 5V, 12V and 24V devices - location and rationale for each type of device in dialysis systems	**A**
b) Principles of electrical safety: ground fault interruption	**K**
c) Principles of operation of sensory and control devices	**K**
d) Use of analog and digital devices and circuits	**K**
e) Principles of operation of transducers, magnetic devices, motors	**K**
f) Principles of electronic troubleshooting	**A**
g) Calibration	**A**
h) Proper handling of static sensitive devices: PCBs, integrated circuits etc.	**A**
i) Interference by radio emitting devices, ie., cell phones	**A**
j) Line isolation	**K**

Competency: Computer Systems in Dialysis	**Level of Questions**
a) Standards and software protocols	**A**
b) Input devices, output devices	**A**
c) Local area networks (LANs) and wide area networks (WANs)	**A**
d) Dialysis specific software options: renal data management packages, treatment data base	**A**
e) Criteria for purchasing decisions: type of PC, operating system, CPU, memory, use of expansion slots and COM/LPT ports	**CT**

f) Software implementation strategies	**CT**

Competency: Haemodialysis On-Line Technologies	**Level of Questions**
a) continuous blood volume monitoring , including automated UF control	**CT**
b) access flow and recirculation measurements	**CT**
c) blood temperature and thermal balance monitoring and control	**A**
d) ionic dialysance	**K**
e) urea concentration and dialysis dose monitoring	**CT**
f) total pool dialysate collection - aliquot method	**K**

Competency: Safety Standards and Directives	**Level of Questions**
a) Overview of standards organisations and scope of their activities (CSA, AAMI, IEEC, TUN, etc.)	**K**
b) Overview of government/health standards agencies (HPB/TPP) knowledge of DIN numbers, procedure for reporting patient side effects to HPB	**K**
c) Electrical installation (home and in-centre) and use of electricity in patient care areas	**A**
d) Water treatment for dialysis	**A**
e) Dialysers and haemofilters	**A**
f) Re-processing of dialysers	**A**
g) Medical equipment risk classification system	**A**
h) Norms and regulations on waste disposal	**K**
i) Specialised guidelines for dialysis: CSN (Canadian Society of Nephrologists), DOQI (Dialysis Outcomes Quality Initiative)	**A**
j) Workplace Hazardous Materials Information System (WHMIS)	**K**

k) Universal precautions	**A**
l) Quality assurance of calibration equipment	**A**
m) Reference individual standards	**K**

Part II Supportive Competencies

Competency: Renal Anatomy Physiology & Pathology	**Level of Questions**
a) Structure of the nephron - location, blood supply, nerve supply, structures	**K**
b) Function of kidneys: excretion/secretion, acid-base regulation, electrolyte balance, fluid balance, blood pressure regulation, endocrine functions (Vitamin D synthesis, erythropoietin secretion, production of renal prostaglandins)	**K**
c) Assessment of kidney function: biochemical and morphological tests	**K**
d) Overview of commonly used medical terminology	**K**
e) Overview of renal failure i. acute renal failure: description, causes (based on location of etiological event - pre-renal, renal and post-renal), stages (initiating, oliguric, diuretic and recovery), typical course of the disease, goals of treatment ii. chronic: description, causes (congenital disorders, cystic disorders, tubular disorders, neoplasms, infectious diseases, obstructions and chronic systemic diseases), stages (stage I decreased renal reserve, stage II renal insufficiency, stage III chronic renal failure), typical course of the disease, goals of treatment	**A**

Competency: Treatment Modalities	**Level of Questions**
a) Haemodialysis: indications for treatment, overview of types (in-centre HD, nocturnal and home haemodialysis, self-setup dialysis centers, routine vs single needle dialysis, paediatric dialysis and complications of all treatment types	**A**

b) Peritoneal Dialysis: indications for treatment, function of the peritoneal membrane, access, complications related to treatment, types of treatment (CAPD, CCPD, IPD) types of cyclers, types of solutions	**K/A**
c) Renal Replacement Therapies: Haemofiltration, Haemodiafiltration, Haemoperfusion (in conjunction with other therapies): differences from HD in configuration of blood and dialysate/substitution fluid circuits, bag and on-line systems with pre and post dilution, fluid balance control systems, warming systems for substitution fluids, use of anticoagulation (monitoring activated clotting time - ACT), Slow Continuous Ultrafiltration (SCUF), Continuous Arterio-venous Hemofiltration (CAVH), Continuous Veno-Venous Hemofiltration (CVVH), Continuous Veno-Venous Haemodiafiltration (CVVHD) - principles of operation, indications for use, type of membrane used	**K/A**
d) Renal Transplantation: indications for transplantation, types of transplant, criteria for recipient selection, care of donor organ, complications of treatment	**K/A**
e) Renal Therapeutic Nutrition: requirements/restrictions for protein, carbohydrates, fats, fluids, vitamins, minerals (Ca, Phosphorus, Potassium etc) assessment of protein catabolic rate (PCR)	**K/A**

Competency: Assessment of Dialysis Adequacy	**Level of Questions**
a) Mathematical models of dialysis adequacy i. For Hemodialysis: Dialysis Index, Urea Kinetic Modelling, standard KT/V, PRU (percentage reduction of urea) equivalent renal clearance. ii. For Hemofiltration: PCR, clearance and exchanged volume in post- and pre-dilution mode in terms of SC, KT/V, QS/QB iii. For PD: PET (peritoneal equilibration test)	**A**
b) Compartment models and their use in RRT: i. Basics of compartment model mathematics (open and closed compartment systems) ii. single-pool and multiple-pool kinetic models iii. first-order kinetics iv. differences for protein bound substances v. regional flow models	**K**

c) Methods and devices for measuring adequacy of dialysis: i. urea enzyme method ii. Na substitution method for urea iii. Aliquot method for pool dialysate collection	**A**

Competency: Access Assessment Techniques & Technologies	**Level of Questions**
a) Types of access: fistula, vascular graft, catheters, other access devices	**K**
b) Evaluation of blood flow through vascular access (Doppler techniques, blood flow dilution techniques)	**A**
c) Recirculation measurement (concentration and dilution techniques), evaluation of pressure	**A**
d) Impact of recirculation on dialysis efficiency (including cardiopulmonary recirculation theory)	**CT**

Competency: Anticoagulation & Coagulometric Technologies	**Level of Questions**
a) review of coagulation cascade	**K**
b) theory of anticoagulation: indications, risks, methods of anticoagulation (systemic, extracorporeal heparinization, no heparinization - NS flushes)	**K**
c) types of anticoagulants: heparin, low molecular weight heparin, citrate, coumadin	**K**
d) interpretation of coagulation times: PT, PTT, INH, ACT (activated clotting time)	**A**
e) principles of coagulometers, including programmable meters evaluating anticoagulant kinetics	**A**

Competency: Complications of Dialysis	**Level of Questions**
a) complications related to the extra corporeal circuit: air embolism, blood leak, exsanguination	**A**
b) complications related to the dialysate: hemolysis, crenation	**K**

c) complications related to the dialyser: type 1 and 2 reactions	**CT**
d) complications related to the access: thrombosis, stenosis, steal syndrome, aneurysm/ pseudo-aneurysm, access re-circulation, needle infiltration, access infection	**K**
e) complications related to the patient: hyper/hypotension, cramps, nausea/vomiting, headache, chest and back pain, febrile reactions, pruritus, dialysis disequilibrium syndrome, arrhythmias, cardiac tamponade/pericarditis/arrest, hypoxemia, stroke	**K**
f) complications related to long term exposure to low level contaminants and chemicals used in dialysis treatment	**A**

Competency: Applied Chemistry	**Level of Questions**
a) basic principles: ions and molecules, principles related to pH, molecular weight, calculations	**K**
b) application of principles of conductivity to dialysate solution: analysis of solutions pre-treatment and safety considerations	**A**
c) molecular structure and function of bio-molecules in blood: sugars, mobile fats, electrolytes, amino acids, blood proteins, hormones, enzymes and immunoglobulins	**K**
d) normal electrolyte levels, serum values of metabolic wastes in ESRD	**K**

Competency: Applied Microbiology	**Level of Questions**
a) chain of infection	**K**
b) pathogens in the dialysis environment: common and multiply resistant organisms, characteristics of the organism	**K**
c) symptoms of infection: local and systemic	**A**
d) methods to control spread of infection by hospital personnel	**A**
e) aseptic technique	**A**
f) category specific and disease specific isolation	**A**
g) universal precautions	**A**

h) controlling contaminations to dialysis equipment & water treatment system	**CT**

Competency: Professional Practice	**Level of Questions**
a) criteria for professional practice: professional credibility, due diligence, self regulation, advanced knowledge, on-going education	**K**
b) confidentiality and consent	**A**
c) professional self regulation: responsibilities for reporting incompetence or malpractice	**K**
d) roles of professional associations: provincial/national engineering technology associations, Canadian Association of Nephrology Nurses and Technologists	**K**
e) Standards of Technical Practice for CANNT	**K**
f) Cultural Sensitivity	**K**

CHAPTER 5
Study Skills & Examination Success Strategies

Because the certification examination is based on both theory and practical experience in dialysis technical practice, you are already on your way to being successful. The examination covers three levels of difficulty of questioning over a number of technical competencies. As such, it is comprehensive in scope. Preparing for the examination requires adequate time and concentrated effort. Studying for the certification examination can be easier if you follow the following steps.

Optimise Your Study Time

Select a study area that is clean, quiet and well lit. Minimize interruptions while you study. Keep your study materials in this location, along with writing materials for note taking.

Develop a plan for approaching your study time, allowing several months for preparation. Start with the Technical Competencies in order of importance (critical competencies first, supporting competencies next). Focus on areas that are **not** your strength. Use the text materials suggested in the Reference List (next chapter) to guide your studying.

Some educators use the **5 R Method**: **record** information in point form, **reduce** the information to key words to help recall, **recite** the key points, **reflect** on the ideas trying to see any patterns or ways of remembering the material and **review** the concepts within a few days to make them more permanent in your memory.

Study for short, intense periods rather than long exhausting marathons. You will find that your retention and retrieval of information is better. Schedule regular breaks in your study periods.

Passive learning is far less effective than a more active, involved method of studying. Focus your efforts by taking point form notes, using a highlighter while reading, cross referencing key points to the Core Competencies (CCs), and using index cards or post-its to create an active learning experience. Drawing sketches, schematics or diagrams will help you to retain information if you are a visual learner.

Studying with others is also helpful, once you have reviewed the content for the first time. The advantage of a study group is that you can clarify your questions, learn from the experience of others and stay motivated. You can also divide content to be studied, have reports or summaries prepared and study from the summaries. You can learn a great deal by posing questions to each other, working through the rationale for the chosen answer.

Exam Success Strategies

Go into the exam well rested and with a positive attitude. Remember that the examination is written to the published standards and is not intended to "trip you up", but rather to assess your knowledge in an area where you already have considerable experience.

Be in the right place at the right time for the exam and have the materials that you will need: 2 pens and 3 soft pencils, sharpened. Put your watch in front of you so that you can see the time and budget it carefully. You will have three (3) hours of writing time. Be sure you have your candidate number and other information handy. Listen to the exam invigilator who will be making announcements about the duration of the exam. If you are uncertain about the instructions, ask for clarification before the examination begins.

Relax, breathe and dive in! Read the instructions carefully and complete the candidate information section of the paper completely. Don't spend too much time on a single question that you are struggling with – move on and come back to it if time permits.

Read each question carefully. Don't make assumptions or read into the question. Look for and highlight key words in each question. This can help you to select the correct answer from the multiple answers available. Samples of key word can include: first, most appropriate, best, always, important etc. Choose and record the best answer, using the method required by the examination. If you decide to change your answer, erase your original choice completely. Be cautious about changing answers – in many cases your first answer will be the most intuitive and may be correct. Change answers only if you are reasonably certain about the change. If you don't know the answer to the question, guess. Use the process of elimination to increase your chances of guessing well.

If you find yourself getting fatigued during the exam, go back and recheck the last few questions for accuracy. Finish up when the adjudicator calls for the paper. If you are finished before the allotted time, use the time to check your paper.

CHAPTER 6
Reference List

The following reference texts are available from the publishers listed below or through the Georgian College Bookstore for a nominal shipping and handling charge. Call the College (705) 728-1968 X 1570.

1. Luehmann, D. and Keshaviah, P. (1989) Manual on Water Treatment for Haemodialysis, US Department of Health and Human Services, Public Health Service, Food and Drug Administration, Rockville, Maryland

This text is available through NANT at Box 2307, Dayton, Ohio 45401 – 2307 or call (937) 586-3705 or email at nant@nant.meinet.com

2. Curtis, J. and Varughese, P., (Eds) (2002) Dialysis Technology: a manual for dialysis technicians, (3rd edition), Dayton, OH: National Association of Nephrology Technicians/Technologists.
This text is available through NANT at Box 2307, Dayton, Ohio 45401 – 2307 or call (937) 586-3705 or email at nant@nant.meinet.com

3. Daugirdas J. and Ing, T., (2001). Handbook of Dialysis (3rd edition) Philadelphia: Lippincott, Williams & Wilkins. ISBN: 0-316-17381-9

This text is available from the publisher at 530 Walnut Street, Philadelphia, PA., USA, 19106 or through the Georgian College Bookstore (705) 728:1968 X 1570.

4. Gutch, C.F., Stoner, M.H., and Corea, A.L. (1999) Review of Haemodialysis for Nurses and Dialysis Personnel (6th ed). St. Louis: Mosby ISBN: 0-8151-2099 –0

This text is available from the publisher at Mosby Publishing, 11830 Westline Industrial Drive, St. Louis, Missouri USA, 63146

5. Nissenson, Allen and Fine, Richard (2002). Dialysis Therapy (3rd ed). Philadelphia: Hanley & Belfus. ISBN: 1-56053-426-5.

This text is available through the publisher: Hanley and Belfus, Inc., Medical Publishers, 210 South 13th Street, Philadelphia, PA 19107 USA (215) 546-7293 or (800) 962-1892 or website www.hanleyandbelfus.com.

CHAPTER 7
Sample Examination

This sample test is not intended to cover every area of the Core Competencies, but rather to familiarize you with writing style and levels of questions. Consult the Core Competencies and Examination Blueprint for more direction on what to study.
After studying material covered in the Core Competencies, prepare about an hour to take the Sample Examination. Read the questions carefully and circle the correct answer. Check your answers with the Answer Key at the end of the test. For study purposes, go back to the reference materials and look up any answers that you do not answer correctly. Remember, the material tested does NOT assess local practices and procedures, but rather the theoretical best practices as indicated in the current reference materials. These are sample questions only and they will not appear on the upcoming examination. Questions are indicated as Knowledge level (K), Application (A) and Critical Thinking (CT) and awarded one, two and three points respectively. This will assist you in gaining confidence with a variety of question types.

1. In the event that an ultraviolet (UV) light is used in the water treatment system, what considerations are most important for the technologist? (CT)

   a) UV is increasingly popular and cost effective

   b) CSA standards require that you use an UV light

   c) Use of UV may increase endotoxin levels in product water

   d) Levels of bacteria in the loop must be assessed and tracked

2. Of the four available dialyser membrane materials, which is the least biocompatible? (K)

   a) Cellulose

   b) Modified cellulose

   c) Cellulo-synthetic

   d) Synthetic

3. Which is a disadvantage of the potting compound in a hollow fibre dialyser? (K)

   a) It is not biocompatible.

   b) It can absorb residual disinfectants.

   c) It can influence the flow dynamics in the dialyser.

d) All of the above.

4. What are the factors that can affect the permeability of a dialyser? (K)

   a) Pore size

   b) Membrane thickness

   c) Unstirred fluid layers

   d) Method of sterilization

5. What will un-stirred layers of fluid on either side of the membrane cause? (K)

   a) Improved clearance

   b) Decreased clearance

   c) Enhanced dialyser clotting

   d) Enhanced clearance

6. In chronic haemodialysis, what can constant exposure to a less biocompatible membrane can result in? (A)

   a) No long-term effects will be apparent as the patient adapts.

   b) Suppression of the immune system, causing a greater risk of infection.

   c) Short-term effects only will be noticed, especially in the first ten minutes of treatment.

   d) Stimulation of the immune system, causing improved ability to fight infection.

7. What microbiological standards apply to the dialyser re-use process? (K)

   a) Potable drinking water standards apply

   b) Endotoxin level of < 5EU by LAL test

   c) AAMI recommended practices for re-use of dialysers

   d) Bacterial count of no more that 100 cfu/ml in treated water

8. What is the best definition of high-level disinfection? (K)

   a) A process that kills most disease producing microorganisms but not spores

   b) A process by which all microorganisms including bacteria, viruses, spores and fungi are killed.

   c) The process of killing vegetative bacteria, tubercle bacilli, most spores, fungi and viruses.

   d) The process of removing disease-producing microorganisms and rendering the object safe for handling.

9. In a re-use program, why are pressure, total bundle volume and in vitro Kuf tested? (A)

   a) To establish the maximum reuse number.

   b) To determine the effect of chemicals on membrane integrity.

   c) To test the clearance and ultrafiltration properties of the membrane.

   d) These tests are not required.

10. What is isolated ultrafiltration? (K)

   a) Removal of fluid

   b) Removal of selected electrolytes

   c) Removal of fluid with little/no change in solute concentration

   d) All of the above

11. What is the sieving co-efficient? (K)

   a) The amount of fluid removed relative to membrane porosity

   b) The total clearance of solutes per volume of blood per unit of time

   c) The amount of solute convected across the membrane in proportion to particle size, relative to pore size.

12. When is the use of an AN69 dialyser not advised? (A)

    a) When the unit's re-processing procedures involve the use of bleach.

    b) When the patient has a history of dialyser reactions.

    c) When the patient is taking angiotension converting enzyme (ACE) inhibitors.

    d) When there is not contraindication for the use of AN69 dialysers.

13. What dialysis machine alarm would not activate the venous line clamp? (A)

    a) Blood leak detector

    b) Arterial pressure alarm

    c) Venous pressure alarm

    d) Transmembrane pressure alarm

14. What is the main factor contributing to arterial (pre-pump) pressure? (K)

    a) Blood pump speed

    b) Arterial tubing diameter

    c) Blood pump over occlusion

    d) Gauge of arterial access needle

15. Which component of the dialysis concentrates prevents precipitation? (K)

    a) Calcium

    b) Chloride

    c) Magnesium

    d) Acetic acid

16. During haemodialysis treatment, the arterial pre-pump pressure has changed from –100 mmHg to –200 mmHg. How would this change affect the actual blood flow? (CT)

    a) No change

    b) Increase by approximately 5%

    c) Decrease by approximately 5%

    d) Decrease by approximately 15%

17. If there were 37 mMol/L of sodium bicarbonate and 4 mMol/L of acetate (or acetic acid) in the concentrates, what bicarbonate concentration would you expect in the dialysate solution? (A)

    a) 33 mMol/L

    b) 41 mMol/L

    c) 37 mMol/L

    d) None of the above

18. Which is not a reason for haemolysis to occur during dialysis treatment? (A)

    a) Mal-occlusion of the blood pump rollers

    b) Partially kinked blood tubing

    c) Clotted catheter

    d) Inadequate blood flow

19. What is the purpose of the bypass function in a hemodialysis delivery system? (A)

    a) To protect the patient from dialysate that is not within safety margins.

    b) To stop dialysis treatment when treatment time is completed.

    c) To change concentrates in mid treatment

    d) To simplify calibration

20. What is the purpose of having a transducer to measure the dialysate flow pressure? (K)

    a) To ensure proper dialysate flow.

    b) To ensure the transfer of electrolytes to the patient.

    c) To stop blood from crossing the dialyser membrane.

    d) To ensure that pressure is lower on the dialysate side to reduce back filtration.

21. In which dialysate delivery system is a pH probe essential? (A)

    a) Sorbent system

    b) Volumetric system

    c) Servo-feedback system

    d) A pH probe is not necessary

22. What is the purpose of the heat exchanger in a dialysis machine? (K)

    a) To heat the incoming water to 37° C

    b) To avoid the dialysate reaching 43° C

    c) To warm the blood before returning it to the patient

    d) To preheat the incoming water before being heated by the machine

23. What is the purpose of using acetic acid 5% in the disinfection process? (K)

    a) To disinfect components

    b) To remove precipitate from the flow path

    c) To remove biofilm layer before heat disinfection

    d) To reduce bacterial growth in the valves of the balancing chamber

24. For 60 Ha AC input, what frequency output does a full wave rectifier produce? (K)

a) 20 Hz

b) 30 Hz

c) 60 Hz

d) 120 Hz

25. What does a strain gauge transducer measure? (K)

a) Pressure

b) Temperature

c) Conductivity

d) Current leakage

26. How can problems with an electrical power source be assessed? (K)

a) Plugging into a different outlet

b) Checking machine and electrical panel circuit breakers

c) Verifying the power cord is secure in the outlet

d) All of the above

27. Which structure prevents red blood cells and protein from being lost in the urine? (K)

a) Glomerulus

b) Distal tubule

c) Loop of Henle

d) Bowman's capsule

28. Under normal conditions, what substance is not contained in glomerular filtrate? (K)

    a) Proteins

    b) Amino acids

    c) Red blood cells

    d) All of the above

29. What is the normal glomerular filtration rate (K)

    a) 30 ml/min

    b) 100 ml/min

    c) 125 ml/min

    d) 450 ml/min

30. How is the choice of exchange volume in peritoneal dialysis dictated? (A)

    a) The age of the patient

    b) The size of the peritoneal cavity

    c) The length of treatment required

    d) The amount of ultrafiltration required

31. What causes rejection of a transplanted kidney? (K)

    a) Poor blood supply

    b) Surgical wound infection

    c) Inadequate antibiotic therapy

    d) Sensitization to human leukocyte antigen

32. Which of the following does not measure dialysis adequacy? (K)

a) Kt/V

b) PRU (percentage reduction of urea)

c) PCR (protein catabolic rate)

d) BMI (body mass index)

33. What is an advantage of a permanent central line over a temporary line? (A)

a) There is less risk of thrombosis.

b) The line will never need to be replaced.

c) Blood flow matches that of a well-developed fistula.

d) Tissue growth around the cuff helps to prevent infection.

34. Why is low molecular weight heparin more beneficial than regular heparin? (A)

a) It has a shorter half life.

b) It is less expensive to produce.

c) It is less likely to cause bleeding.

d) It has a greater effect on circulating proteins.

35. What is the heparin prescription where clotting time is maintained at 1.5 – 2 times baseline? (K)

a) A routine heparin prescription

b) A “tight” heparin prescription

c) A regional heparin prescription

d) A citrated heparin prescription

36. Which protein is routinely lost in peritoneal dialysis? (K)

    a) Albumin

    b) Fibrinogen

    c) Immunoglobulin

    d) Gamma globulin

37. Which of the following is not part of the “chain of infection”? (K)

    a) Dormancy

    b) Portal of exit

    c) Source of infection

    d) Mode of transmission

38. What is the principle mode of transmission of methicillin-resistant staphylococcus aureus in a dialysis unit? (K)

    a) Direct contact

    b) Needle stick injuries

    c) Airborne transmission

    d) All of the above

39. What method is used when care is provided with the assumption at all patients are potentially infectious? (K)

    a) Laminar flow

    b) Universal precautions

    c) Adequate air exchange

    d) Good housekeeping practices

40. What is meant by the term, “due diligence”? (K)

a) Taking sufficient and appropriate care to avoid causing harm to others.

b) Maintaining records that demonstrate standards have been followed.

c) Reporting conditions that are unsafe as dictated by current standards.

d) Providing oneself with professional malpractice insurance coverage.

41. What statement best defines professional misconduct? (K)

a) Accepting favours from equipment vendors

b) Inadequately documenting equipment malfunctions

c) Failure to disinfect the water treatment system as required

d) Improper behaviour, considered unbefitting the profession.

42. What is the role of provincial engineering technology associations across Canada? (K)

a) Evaluation of candidate document to determine eligibility for certification.

b) Conferring title to those candidates who successfully certify in their field.

c) Prevention of the use of title by individuals not certified by the association.

d) All of the above.

Answer Key

1. **c and d**
2. **a**
3. **b**
4. **a and b**
5. **b**
6. **b**
7. **c**
8. **c**
9. **d**
10. **c**
11. **c**
12. **c**
13. **d**
14. **d**
15. **d**
16. **d**
17. **a**
18. **d**
19. **a**
20. **d**
21. **c**
22. **d**
23. **b**

24. d

25. a

26. d

27. a

28. c

29. c

30. b

31. d

32. d

33. d

34. c

35. a

36. a

37. a

38. a

39. b

40. a

41. d

42. d