(9205-QE)

SBB/BB Exam Review

October 7, 2012 ✦ 8:30 AM - 12:00 PM
Event Faculty List

Event Title: 9205-QE: SBB/BB Exam Review
Event Date: Sunday, October 7, 2012
Event Time: 8:30 AM to 12:00 PM

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**SBB/BB Exam Review**

**The SBB and BB Exams**

Requirements
Content
Competencies

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**ASCP Exam Requirements**

- Refer to ASCP website (www.ascp.org) for specific requirements
  - Click on Board of Certification
  - Then US Certification
  - Numerous options to select…more about that later
- Wealth of information available there!

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**SBB Exam Requirements:**

- 4 eligibility routes
- Most common:
  - **Route 1**
    - Bachelor’s degree with required courses
    - Successful completion of CAAHEP-accredited SBB program within last 5 years
  - **Route 2**
    - MT/MLS(ASCP) or BB(ASCP)
    - Bachelor’s degree
      - Course requirements met through MT/BB certification
    - 3 yrs full-time BB experience within last 10 years after degree
    - Must be attained with pathologist oversight
**BB Exam Requirements:**

- 5 eligibility routes
- Most common
  - **Route 1**
    - MT/MLS(ASCP) and Bachelor’s degree
  - **Route 2**
    - Bachelor’s degree in appropriate field with required courses
    - 1 yr full-time BB experience within last 10 years
      - Must be attained with pathologist oversight

**Experience Requirements**

- Serologic Testing
  - ABO, Rh Typing
  - Antibody detection and identification
  - Cross matching
  - Tests for other blood group antigens
  - Direct antiglobulin tests

**Experience Requirements**

- Routine Problem Solving
  - Transfusion reactions
  - Immune hemolytic anemias
  - Hemolytic disease of the newborn
  - Rh immune globulin evaluation
Experience Requirements

• Quality Control/Quality Assurance
• Laboratory Operations
• Donor Blood
  – Donor selection, preparation and collection
  – Processing and confirmation testing
  – Component preparation for storage and administration

Competencies

• Knowledge of advanced principles
• Technical skills
• Problem Solving & Analytical Decision Making
• Communication
• Teaching & Training Responsibilities
• Supervision & Management

Exam Category Percentages

<table>
<thead>
<tr>
<th>Subtest</th>
<th>BB</th>
<th>SBB</th>
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<tbody>
<tr>
<td>Blood Products</td>
<td>12%</td>
<td>10%</td>
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<tr>
<td>Blood Group Systems</td>
<td>15%</td>
<td>17%</td>
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<tr>
<td>Immunology</td>
<td>8%</td>
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<tr>
<td>Laboratory Operations</td>
<td>7%</td>
<td>10%</td>
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<tr>
<td>Physiology/Pathophysiology</td>
<td>13%</td>
<td>17%</td>
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<tr>
<td>Serology</td>
<td>33%</td>
<td>22%</td>
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<tr>
<td>Transfusion Practice</td>
<td>12%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Additional information

- Available on ASCP website (www.ascp.org)
  - Click on Board of Certification / US Certification
    - Eligibility
    - Documentation
    - Applying
    - Scheduling
    - Studying
      - Content outline
      - Reading list
    - Exam Day
    - Results and Certificate
    - US Military

SBB/BB Exam Review

Blood Groups

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Part of the Johnson & Johnson Family of Companies
Raritan, NJ

Most Important

Read and know:
- Technical Manual
- Standards
- CAUTION
**General**

Antigens
- Genetics
- Biochemistry
- Null phenotype
- Effect of chemicals
- Prevalence

**General**

Antigens, cont.
- Racial variation
- Cord cell expression
- Soluble antigens

**General**

Antibodies
- Characteristic reactivity
- Techniques for detection/confirmation
- HTR
- HDFN
ABO
- Gene interaction - A, B, H, Se
- Antigen structure
- Immunodominant sugars
- Subgroup characteristics
- Causes of ABO discrepancies
- Resolution of ABO discrepancies
- Soluble antigen
- Important lectins

MNS
- 5 terminal amino acids for M and N specificity
- Prevalence in both White and Black populations
- Chemical treatment
- Hybrid SGPs

P and Globoside
- Soluble antigen
- Autoanti-P and PCH
- Anti-PP_{1}P^{k} and spontaneous abortion
**Rh**

- Rh complex
- Types of Weak D
- Inheritance of Rh\textsubscript{null}
  - Lack LW and Fy5
- Prevalence of 5 major antigens
- Antigens associated with D variants

**Rh**

- Compound antigens/antibodies
- Anti-G adsorption/elution
- Standards for D typing
- HTR
- HDFN

**Kell**

- Gene interaction
- Racial differences
- Chemical treatment
- KEL3 in \textit{cis} position
- McLeod phenotype
**Lewis**
- Soluble antigen
- Antigen structure
- Gene interaction - Le, H, Se

**Duffy**
- Racial differences
- Chemical treatment
- Anti-Fy3 vs Anti-Fy5
- Association with Malarial resistance

**Kidd**
- Inheritance for Jk(a-b-)
- Jk(a-b-) resistant to lysis in 2M urea
- Jk(a-b-) population
Other

Lutheran
- Lu(a-b-) inheritance
- Lu linkage to Se
- Association with ALG

Other

LW
- Association with D
- Cord cell expression
- Distinction from D
- Absence on Rhnull

Other

I System/Collection
- Soluble antigen
- Adult and cord cell expression
- Disease associations
Other

- Diego
- Cartwright
- Scianna
- Dombrock
- Colton
- Indian
- Xg

High Incidence Antigens

Problem solving
- Phenotype clues
- Chemical treatment
- Ethnicity of antibody maker
- Source of units for transfusion
- HDFN

Former HTLA

- Chido/Rogers
  - Chemical treatment
  - Soluble antigen
  - C4 coated cells
- Knops
  - Located on CR1
  - Ethnicity of antibody maker
  - Soluble antigen
Former HTLA

- Dombrock
  - Gy and Hy
- Cost
- JMH
  - Chemical treatment

SBB/BB Exam Review

Methods
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General

- Read Technical Manual Methods Section
- Principle of Method
- Interpretation of Method
- Applications of Method
- Limitations of Method
Antigen/Antibody Reactions

- Agglutination
  - Stages
  - Factors affecting agglutination
- Hemolysis
- Precipitation
  - Applications
  - Double diffusion

Antigen/Antibody Reactions

- Complement Fixation
- ELISA
  - Direct assay
  - Competitive assay
- RIA

Flow Cytometry

- Principle
- Gating
- Applications
  - Define cell markers
  - Detect minor cell populations
  - Antigen zygosity
**Red Cell Survival**

- Applications
- Monocyte Monolayer Assay
  - Principle
- In vivo crossmatch
  - Principle

**Adsorption**

- Types
- Variables
  - Temperature, incubation time, etc.
- Applications
  - Remove autoantibody
  - Separate multiple antibodies
  - Confirm antigen or antibody specificity

**Elution**

- Principle
- Types
  - Optimal recovery
  - Limitations
- Applications
  - Investigate positive DAT
  - Remove antibody for phenotyping
**Titration**

- Be able to interpret a titration scheme
- Be careful about phenotypes of cells used
- Know how to score
- Applications
  - Prenatal studies
  - Antibody identification
  - Separate antibody specificities

**Neutralizations**

- Principle
- Look for Dilutional Control
- Sources and specificity of soluble substances
  - ABH
  - Lewis
  - P₁
  - Sd⁺
  - Ch/Rg

**Cell Separations**

- Applications
- Microhematocrit
  - Principle
  - Limitations
- Hypotonic Wash
  - Principle
  - Sickle cell disease
Chloroquine Diphosphate

- Applications
  - Dissociate antibody from red cells
  - Denature Bg and HLA-related antigens
- Limitations
  - Complement not removed
  - Some antigens weakened with prolonged exposure

Antilymphocyte Globulin

- Made from horse serum
- Interferes with DAT and IAT
- Relation to Lu(a-b-)
- Know how to resolve

Enzymes

- One stage vs two stage
- Standardization procedure
  - Method
  - Interpretation
- Effect on various antigens
**Sulphydryl Reagents**

- AET, DTT, 2ME
- Principle
- Applications
  - Antigen
  - Antibody - know how to interpret serum treatment (look for dilutional control)

**Enhancement Techniques**

- Strengths and weakness of each
- LISS
- PEG
- Polybrene
- Bovine Albumin

**Non-Traditional Techniques for Antibody Detection/Identification**

- Column Agglutination Technology
  - Principle
  - Unique components of system
- Solid Phase Red Cell Adherence
  - Principle
  - Unique components of system
Other

- Donath-Landsteiner Test
  - Diagnosis of PCH
  - Method and interpretation
- Tests for PNH
  - Sucrose lysis
  - Ham's test

Polymerase Chain Reaction (PCR) and Transcription-Mediated Amplification (TMA)

- Principle
- Procedure
- Applications
  - PCR used for DNA amplification
  - TMA used for RNA amplification

SBB/BB Exam Review

Blood Donors

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**Donor Identification**
- Identification
- Donor Education and Consent
- Donor Qualifications
  – review most current edition of Standards

**Autologous Qualifications**
- Physicians order
- Hgb ≥11 g/dl or Hct ≥33%
- Collected > 72 hours before surgery or transfusion
- Deferred if there is a risk of bacteremia

**Apheresis Qualifications**
- Same requirements as allogeneic donors with the exception of donation interval
- Infrequent donor
  – donates no more than once every 4 weeks
- Frequent donor
  – donates more frequently than once every 4 weeks
  - max of twice / 7 day period
  - at least 2 days between donations
**Plasmapheresis**

- Frequent or Infrequent

**Cytapheresis**

- Frequent or Infrequent
- Not to exceed 24 donations / year
- Regular testing for cytopenia
- Monitor red cell loss and defer appropriately

**Plateletpheresis**

- Frequent donors must have a platelet count performed before beginning the procedure and have a count ≥ 150,000
  - pre procedure plt count not required for infrequent donors
  - post procedure plt count may be used to qualify the donor for the next procedure

**Two-unit Red Cell Apheresis**

- Hgb / Hct and weight according to FDA cleared device
- Generally:

<table>
<thead>
<tr>
<th>Allogeneic Male</th>
<th>Allogeneic Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight ≥130 lb</td>
<td>≥150 lb</td>
</tr>
<tr>
<td>Height at least 5'1&quot;</td>
<td>at least 5'5&quot;</td>
</tr>
<tr>
<td>HCT at least 40%</td>
<td>at least 40%</td>
</tr>
<tr>
<td>HGB at least 13.3 g/dl</td>
<td>at least 13.3 g/dl</td>
</tr>
</tbody>
</table>

- Donor Hct not <30% or Hgb not <10g/dl after volume replacement
**Unit Identification**

- Numeric or alphanumeric system for traceability

**Phlebotomy and Collection of Samples**

- Clean site to reduce bacterial contamination
- Anticoagulated blood in segments
- Matching ID on unit, donor form, and samples
- Wear gloves when collecting autologous donors

**Post-Phlebotomy Care**

- Apply firm pressure
- Remain reclined until released
- Give the following instructions:
  - eat and drink before leaving
  - do not leave until released
  - drink a lot of fluid over the next few days
  - avoid alcohol until after a good meal
  - do not smoke for 30 minutes
  - if phlebotomy site begins to bleed, raise arm and apply pressure
  - lie or sit down if feel faint or dizzy
  - return to blood bank if symptoms persist
  - remove bandage after a few hours

**Adverse Donor Reactions**

- General
- Fainting
- Nausea and Vomiting
- Twitching or muscle spasms
- Hematoma during or after phlebotomy
- Convulsions
- Serious cardiac difficulties
- Record all incidents
Anticoagulants

- Prevent clotting and maintain cell viability and function during storage
  - Dextrose: supports ATP generation
  - Adenine: provides substrate for ATP synthesis
  - Sodium biphosphate: controls the pH
  - Citrate: prevents coagulation
- 21 day storage = CPD, CP2D
- 35 day storage = CPDA-1
- 42 day storage
  - AS-1 (Adsol), AS-3 (Nutricel), AS-5 (Optisol)

Red Cell Components

- Whole blood (1-6°C)
- Red Blood Cells (1-6°C)
- Frozen Red Blood Cells (-65°C or colder)
- Rejuvenated RBCs (1-6°C)
- Deglycerolized RBCs (1-6°C up to 24 hours)
- Washed RBCs (1-6°C up to 24 hours)
- Pre-storage RBCs Leukoreduced
- Low Volume RBCs
- Apheresis RBCs
- Intraoperative RBCs
**Plasma Components**
- Fresh Frozen Plasma
- Thawed Plasma
- Plasma Frozen Within 24 hours of collection
- Plasma and Liquid Plasma
- Plasma Cryoprecipitate Reduced
- Solvent/Detergent-Treated Pooled Plasma
- Donor Retested Plasma
- "Linked" FFP
- Recovered Plasma
- Cryoprecipitate

**Platelets**
- Platelet Concentrates
- Platelet - Apheresis
- Modifications of platelets
  - Irradiated
  - Leukoreduced
  - Volume-reduced
  - Aliquots
  - Washed
  - Frozen

**Granulocytes**
- Usually collected by apheresis
- Buffy coat harvest
- Yield must be a minimum of $1.0 \times 10^{10}$ granulocytes
- Transfuse as soon as possible after collection
**Component Modifications**

- CMV-negative
  - reduces the risk of CMV transmission
  - leukoreduced may be an alternative
- Irradiated
  - prevents T lymphocyte proliferation; the primary cause of GVHD

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**Effects of Storage on Blood Components**

- ↓ 2,3 DPG levels
- ↓ ATP
- ↑ K+

<table>
<thead>
<tr>
<th>Variable</th>
<th>Whole Blood</th>
<th>RBCs</th>
<th>WBCs</th>
<th>plasma</th>
<th>PRBCs</th>
<th>WBCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days of Storage</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>20</td>
<td>42</td>
</tr>
<tr>
<td>pH measured at 2°C</td>
<td>7.2</td>
<td>6.8</td>
<td>6.8</td>
<td>6.8</td>
<td>6.8</td>
<td>6.8</td>
</tr>
<tr>
<td>[% of initial value]</td>
<td>99.9</td>
<td>99.5</td>
<td>99.0</td>
<td>98.0</td>
<td>97.0</td>
<td>96.0</td>
</tr>
<tr>
<td>Plasma K (mEq/l)</td>
<td>3.3</td>
<td>3.4</td>
<td>3.5</td>
<td>3.6</td>
<td>3.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Plasma Mg (mEq/l)</td>
<td>1.7</td>
<td>1.5</td>
<td>1.3</td>
<td>1.1</td>
<td>0.9</td>
<td>0.7</td>
</tr>
</tbody>
</table>

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**Oxygen Dissociation Curve**

- Based on affinities of tissues for oxygen
- Relationship between pO₂ and O₂ saturation of HGB
- pO₂: oxygen pressure of tissues
- p50: pO₂ level at which HGB is 50% saturated
- A normal p50 corresponds to ~25 pO₂
  - ↑ p50 = right shift; more oxygen released
  - ↓ p50 = left shift; less oxygen is released
**General Requirements**

- ABO and Rh
- Antibody Screen
  - with history of transfusion or pregnancy
- ALT
  - not required by the FDA or AABB
  - plasma sales for further manufacturing
General Requirements (cont.)

- HBsAg
- Anti-HBc
- Anti-HCV
- HCV-RNA (NAT)
- Anti-HIV-1/2
- HIV-1 RNA (NAT)
- Anti-HTLV-I/II
- WNV RNA
- Syphilis
- Antibodies to Trypanosoma cruzi (tested once)
- Bacterial Detection (platelets)

Hepatitis B Infection

- Anti-HBs and Anti-HBc persist after recovery and indicate immunity
- HBsAg and Anti-HBc persist in chronic carriers while Anti-HBs is absent

Invalidation of Test Results

- Faulty equipment, improper procedure, compromised reagents and/or
- Internal control results do not meet package insert acceptance criteria
  - all results, reactive and non-reactive, must be rejected
  - all specimens must be tested in a new run which becomes the test of record
**Acceptable Test Results**

- No error in test performance
- Internal batch controls are acceptable
  - remains test of record
  - reactive results must be retested in duplicate, per manufacturer’s instructions

**External Controls**

- Purchased commercially
- Used for surveillance of test performance
- Tested the same as donor samples
- *Non-reactive test results can be invalidated based on the external controls but if all other manufacturer’s guidelines were followed, external controls cannot be used to invalidate reactive test results*

**Supplemental and Confirmatory Tests**

- Neutralization: HBsAg and HIV-1Ag
- Western Blot: Anti-HIV
- RIBA: Anti-HCV
- Anti-HTLV confirmation
Re-entry Algorithm

**HTLV Testing**
- Indefinite deferral:
  - 2 or more reactive HTLV EIA screening assays
  - 1 reactive HTLV EIA screen and 1 reactive HTLV EIA by second manufacturer
- 8-week eligible:
  - 1 reactive HTLV EIA screen and negative screen by second manufacturer

**HIV/HCV NAT re-entry**
- No algorithm available from the FDA

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SBB/BB Exam Review

**Transfusion Practice**

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### Basics

Components are used for:
- Oxygen delivery
  - Red blood cells
- Correct coagulopathies
  - plasma, platelets, and cryoprecipitate
- Replace deficient coag factors
  - plasma and cryoprecipitate
- Fight infections
  - Leukocytes

---

### Whole Blood

- Used infrequently
- Increases both oxygen carrying capacity and plasma volume

### Red Blood Cells

- Used for increasing oxygen carrying capacity
  - Leukocyte-reduced
  - Washed
  - Frozen, deglycerolized

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### Fresh Frozen Plasma

- Used to treat coagulation deficiencies

### Cryoprecipitate

- Provides Factor VIII, fibrinogen, vWF, Factor XIII
- Small amounts can be used for “fibrin glue”

### Cryo-poor Plasma

- Primarily used to treat TTP patients
Platelets

- Improve hemostasis
- Given when patient is bleeding, the platelet count is low, and/or the platelets are not working properly
- Do not give for TTP or ITP unless absolutely necessary

Granulocytes

- Used to fight infection
- Should be irradiated

References

- Practical Guide to Transfusion Medicine by Petrides and Stack
- Therapeutic Apheresis: A Physician’s Handbook, 1st edition
- Transfusion Medicine Self Assessment and Review by Helekar, Blackall, Winters, Triulzi

Case Study #1

- Jack is rushed to the ER after falling down a hill. It appears that Jack has lost 1/3 of his blood volume. What is the component of choice for transfusion?
- Jack needs both oxygen carrying capacity and an increase in his blood volume therefore, transfuse with whole blood or RBCs and plasma.
Case Study #2

- Jack’s has ruptured his spleen and he is immediately taken to surgery. The surgeon ordered apheresis platelets to be given. When should the platelets be administered?
- After the splenic artery is clamped.

Case Study #3

- Jill was recently diagnosed with TTP. Her physician has ordered a 3L therapeutic plasma exchange. What is the replacement fluid of choice?
  - Cryo-poor plasma is the replacement fluid of choice but plasma is also acceptable.

Case Study #4

- Susie was admitted to the hospital with severe septicemia. She is not responding to antibiotics. What blood product may be useful in her treatment?
  - Granulocytes if she is an adult.
  - Buffy coat if she is a neonate or small child.
**Mendel’s Principles**

- Random segregation
  - Distinct units (genes) inherited
  - one from each parent
  - random
- Independent assortment
  - Genes inherited independently if carried on different chromosomes
  - Combinations of genes are not dependent on other genes (Exception: linkage)

**Definitions**

- Dominant/Recessive
- Genotype/Phenotype
- Crossover
- Recombination
- Allele
- Locus
- Cis/Trans
- Homozygous/Heterozygous/Dosage
Genetic Symbols

• See Study Guide and current Technical Manual...

Types of Inheritance

• Autosomal Dominant
  – Trait appears in every generation; no "skipping"
  – Trait is transmitted by an affected person to half his children on the average
  – Unaffected persons do not transmit the trait to their children
  – Occurrence and transmission of the trait are not influenced by sex; equally likely in both males and females

Types of Inheritance

• Autosomal recessive
  – Trait appears in sibs, not in their parents or offspring
  – On the average, one-fourth of sibs of propositus are affected
  – Parents of the affected child may be consanguineous
  – Males and females equally likely to be affected
Types of Inheritance

• Sex-linked dominant
  – Affected males transmit the trait to all daughters and to no sons
  – Affected females (heterozygous) transmit to half of their children of either sex.
  – Homozygous females transmit to all their children
  – Distinguished from autosomal dominant only by offspring of affected males

Types of Inheritance

• Sex-linked recessive
  – Incidence of the trait is much higher in males than females
  – Trait passed from affected man through all daughters to half of sons
  – Trait is never transmitted directly from father to son
  – Trait may be transmitted through a series of female carriers

Types of Inheritance

• Y-linked
  – Resembles X-linked
  – Trait is transmitted only from father to son, never to daughter
  – All sons will be affected
**Chromosome locations of blood groups**

- Chromosome 1
  - Rh, Duffy, Scianna, Cromer, Knops
- Chromosome 9
  - ABO
- Chromosome 19
  - Lutheran, Lewis, LW, Hh

**Population Genetics**

- Hardy-Weinberg Equation
- Basic formula: $(a + b)^2$
  - Two heterozygous parents: $(Aa \times Aa)$
  - Offspring: $1AA + 2Aa + 1aa$

<table>
<thead>
<tr>
<th></th>
<th>Mom</th>
<th>Dad</th>
</tr>
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<tbody>
<tr>
<td>Aa</td>
<td></td>
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<tr>
<td>AA</td>
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<td>Aa</td>
</tr>
<tr>
<td></td>
<td>Aa</td>
<td>aa</td>
</tr>
</tbody>
</table>

**Hardy-Weinberg Equation**

- Generalized equation:
  - $(p + q)^2 = p^2 + 2pq + q^2 = 1$
  - For 2 alleles: $p + q = 1 \text{ or } q = 1 - p$
  - Expanded: $p^2 + 2p(1 - p) + (1 - p)^2 = 1$
Example
• Assume that in a given population
  84% of the individuals are D positive
  and 16% are D negative (d):
  – p = gene frequency of D
  – q = gene frequency of d
  – Then:
    
    \[
    \begin{align*}
    \text{Homozygous (DD)} &= p^2 = 0.84 \\
    \text{Heterozygous (Dd)} &= 2pq \\
    \text{D negative (dd)} &= q^2 = 0.16 \\
    \hline
    \text{Total} &= 1.00
    \end{align*}
    \]

Example, cont.
– \( q^2 = 0.16 \), so \( q = \sqrt{0.16} = 0.4 \)
– \( p + q = 1 \) and \( p = 1 - q = 1 - 0.4 = 0.6 \)
  • \( p = 0.6 \)
  • \( q = 0.4 \)
– Therefore:
  • \( DD = p^2 = (0.6)^2 = 0.36 \)
  • \( Dd = 2pq = (2)(0.6)(0.4) = 0.48 \)
  • \( dd = q^2 = (0.4)^2 = 0.16 \)

Three assumptions for Hardy-Weinberg equilibrium
• Individuals of each genotype must be as
  reproductively fit as individuals of any
  other genotype.
• Population must have large number of
  individuals.
• Random mating must occur.
**Calculations**

- Gene and phenotype frequencies are based on probability.
  - A number of individuals in any population are tested and the frequency of the trait is determined in that population.
  - It is assumed, based on probability, that the frequency of the trait in the population is equivalent to the frequency in the tested population.
- To determine the frequency of any two (or more) unrelated traits, simply multiply the frequencies of each trait.

**Example:**

- A patient has an anti-E and anti-K. How many units of ABO compatible RBCs must be tested to find three compatible units?
  - Approx. 30% of population E positive
    - (70% E negative)
  - Approx. 10% of population K positive
    - (90% K negative)
  - $0.7 \times 0.9 = 0.63$ (or 63% of population is negative for E and K)
- Therefore, approximately 3 out of 5 random units would be negative for K and E.

**Caution!**

- Beware of racial differences
  - (i.e. Duffy antigens in Black population).
**Hardy-Weinberg Example 1**  
*(2 allele system):*  
- Trait is autosomal dominant; occurs in 51% of the population. What is the gene frequency?  
  \[ p^2 + 2pq + q^2 = 1; \quad p + q = 1 \]  
  - \( p \) = GF of dominant trait  
  - \( q \) = GF of recessive allele  
  \[ p^2 + 2pq = 0.51; \quad q^2 = 0.49 \]  
  - \( q \) = 0.7  
  - \( p \) = 1 - 0.7 = 0.3

**Hardy-Weinberg Example 2**  
*(2 allele blood group system):*  
- Population studies reveal that 27% type Jk\(^a\) negative. What are the gene frequencies of Jk\(^a\) and Jk\(^b\) in this population? What percentage are Jk(a+b+)?  
  \[ p^2 + 2pq + q^2 = 1; \quad p + q = 1 \]  
  - \( p \) = gene freq. of Jk\(^a\); \( q \) = gene freq. of Jk\(^b\)  
  \[ q^2 = 0.27; \quad q = 0.52 \quad (Jk^b) \]  
  - \( p \) = 0.48 \quad (Jk\(^a\))  
  - 2pq = 0.50 \quad (Jk(a+b+))

**Hardy-Weinberg Example 3**  
*(3 allele blood group system):*  
- 3 Genes: \( p + q + r = 1 \)  
- Phenotypes:  
  \[ p^2 + 2pq + q^2 + 2qr + r^2 + 2pr = 1 \]  
  - Homozygous: \( p^2 = AA; \quad q^2 = BB; \quad r^2 = OO \)  
  - Heterozygous: \( 2pq = AB; \quad 2qr = BO; \quad 2pr = AO \)
**Hardy-Weinberg Example 3**  
*3 allele blood group system:*

- Our population has:
  - 28% A (AA, AO) - 53% O (OO)
  - 15% B (BB, BO) - 4% AB (AB)

- O’s: \( r^2 \); \( r^2 = 0.53 \); \( r = 0.73 \)
- A’s & O’s: \( p^2 + 2pr + r^2 = 0.81 \)
  \( (p + r)^2 = 0.81 \); \( p + r = 0.90 \)
  \( p = 0.90 - 0.73; p = 0.17 \)
- \( p + q + r = 1 \)
  \( q = 1 - (p + r); q = 1 - 0.90; q = 0.10 \)

**Hardy-Weinberg Example 3**  
*3 allele blood group system:*

- G.F. (A \( [p] \)) = 0.17
- G.F. (B \( [q] \)) = 0.10
- G.F. (O \( [r] \)) = 0.73

- What is percentage of BO individuals in this population?
  \( 2qr = 2 (0.10)(0.73) = 0.146 \) or 14.6%

**Another problem...**

- A father’s genotype is BO and the mother is OO? What is the probability that they will have 3 OO children in a row?
  
  Each time the probability is 50% (or 0.5).
  
  \( 0.5 \times 0.5 \times 0.5 = 0.125 \) or \( 1/8 \)
SBB/BB Exam Review

Coagulation

William Turcan, MT(ASCP)SBB
Brenda Barnes, MEd, MT(ASCP)SBB

Traditional Pathway

"The old pathways..."
The Players

Most of the coagulation proteins are either enzymes (serine proteases) or cofactors.

<table>
<thead>
<tr>
<th>Enzymes</th>
<th>Cofactors</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor IIa</td>
<td>Tissue factor</td>
<td>Fibrogen</td>
</tr>
<tr>
<td>Factor VIIa</td>
<td>Factor V</td>
<td>Factor XIII</td>
</tr>
<tr>
<td>Factor Xa</td>
<td>Factor VIII</td>
<td>Alpha₂ antiplasmin</td>
</tr>
<tr>
<td>Factor Xa</td>
<td>Protein S</td>
<td>PAI-1</td>
</tr>
<tr>
<td>Protein C</td>
<td></td>
<td>Antithrombin</td>
</tr>
<tr>
<td>TPA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasmin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Enzymes

- Factors II, VII, IX, X, protein C and protein S
  - Vitamin-K dependent
    - Without vitamin K, dysfunctional proteins are produced
      - Bleeding can occur
    - Warfarin blocks recycling of vitamin K

Cofactors

- Cofactors V and VIII
  - Similar molecules
  - Require activation by thrombin
  - Enhances efficiency of coagulation factors by at least 100,000-fold
  - Defects in both proteins result in common hemostatic problems
“Coagulation Factory”

- Enzyme binds a cofactor which is bonded by calcium to a surface
  - Enzyme – VIIa, IXa, Xa, IIa, protein C
  - Cofactor – V, VIII, tissue factor, protein S
    - Speeds up reactions by orders of magnitude
  - Calcium – binds protein to surfaces
  - Phospholipid surface
    - Negative charge
    - Brings proteins closer together

The “New” Model

The Formation of Fibrin Clot
### What about the other players?

- **Contact system**
  - XII, kallikrein (also HK, PK)
  - Plays a role in inflammation
  - Deficiencies do not cause bleeding
- **XI**
  - Deficiencies cause bleeding, especially after surgery
  - Role is still emerging....

### Thrombin (IIa)

- Multifunctional molecule
  - Cleaves fibrinogen into fibrin
  - Activates Factors V and VIII
  - Activates Factor XIII
  - Activates Factor XI
  - Activates platelets
  - Activates thrombin activatable fibrinolysis inhibitor (TAFI)
  - Activates Fibrinolysis
  - Activates protein C

### Fibrinolysis

- Breakdown of formed blood clots
  - Keeps thrombi from getting too large
  - Aids in wound healing
  - Prevents thrombosis in undesirable places
- **Key proteins:**
  - Plasminogen and Plasmin
  - Tissue Plasminogen Activator (tPA)
  - Urokinase (UK)
  - Inhibitors:
    - Plasminogen Activator Inhibitor (PAI-1)
    - Alpha₂ Antiplasmin
**Fibrinolytic Pathway**

```
PLASMINOGEN  
\rightarrow IPA \rightarrow PLASMIN 
\rightarrow PAI-1 \rightarrow ANTIPLASMIN
```

**Natural Anticoagulants**

```
TFPR \rightarrow TF + VIIa  
\rightarrow IX + VIII \rightarrow X + V \rightarrow CLOT
```

**Platelets**

- Produced in bone marrow
- Megakaryocyte – precursor
  - One megakaryocyte can produce 2,000 platelets
  - Platelets bud off edge
  - Megakaryocyte eventually perishes
- Platelet lifespan is 7-10 days
- Platelets circulate freely or are sequestered in spleen
  - 1/3 of platelets are usually located in spleen
Function of Platelets

- **Adhesion** to damaged endothelium
- **Storage** of ADP and proteins
- **Aggregation** with other platelets
- Provide **surface** for coagulation reactions

---

Platelet Adhesion

![Diagram](DeLoughery_T_Hemostasis_and_thrombosis_2nd_ed_2004)

---

Platelet Structure - Storage

![Diagram](DeLoughery_T_Hemostasis_and_thrombosis_2nd_ed_2004)
Activated Platelet

GP Ib

ADP

vWF

FACTOR V

GP IIb/IIIa Receptors

GP Ib

vWF

GP IIb/IIIa

Platelet Aggregation

FIBRINOGEN
Prothrombin Time (PT)

- Measures time from formation of TF+VIIa complex to clot formation
  - Plasma + Calcium + Tissue Thromboplastin
- Major use is to monitor warfarin therapy
- Monitors Extrinsic pathway

Activated Partial Thromboplastin Time (aPTT)

- Activator is added to plasma
  - Plasma + Calcium + Kaolin + Phospholipids
- Measures speed of contact pathway
  - (XII, kallikrein, XI) → IXa+VIIIa → Xa+Va → IIa → CLOT
- Monitors Intrinsic pathway

International Normalized Ratio (INR)

- Method of standardizing PT times obtained at different labs
- Derived by dividing PT time by control value and raising it to the International Sensitivity Index (ISI)
  - ISI is known for each PT reagent
- Use of INR results in better patient monitoring
Coagulation Disorders

- Primary Hemostasis
  - Vascular
  - Platelets

- Secondary Hemostasis
  - Coagulation factors

Primary: Vascular

- Marfan's Syndrome
- Hereditary Hemorrhagic Telangiectasia

- Easy bruising/bleeding
- Painful

Primary: Platelets

- ITP
  - Idiopathic Thrombocytopenic Purpura
  - Immune complexes
  - IVIG

- TTP
  - Thrombotic Thrombocytopenic Purpura
  - Platelet/Fibrin microthrombi
  - Plasma exchange
Primary: Platelets

- Glanzmann's Thrombasthenia
  - GP IIb/IIIa abnormal
  - Aggregation test abnormal with: epinephrine, collagen, ADP (Normal with: ristocetin)
- Bernard-Soulier syndrome
  - GP Ib abnormal
  - Aggregation test normal with: epinephrine, collagen, ADP (Abnormal with: ristocetin)

Platelet or HLA antibodies

- Anti-HPA-1a
- Anti-HLA (Class I)

- Treat platelets with Chloroquine diphosphate
  - Denatures HLA (Bg) antigens

Aspirin Effect

- Inhibits platelet function by Acetylation of Platelet Cyclo-oxygenase
- Leads to decreased Thromboxane-A₂ formation
- Platelets can adhere to collagen and release granules, but cannot aggregate
- Cannot be used as a sole source of platelets, but can be used in a pool
Primary: vWD

- von Willebrand’s Disease (many types)
- Type 1 treated with DDAVP
- All others treated with Factor VIII that contains vWF
- Humate-P

Secondary: Coagulation Factors

<table>
<thead>
<tr>
<th></th>
<th>PT Normal</th>
<th>PT Abnormal</th>
</tr>
</thead>
<tbody>
<tr>
<td>APTT Normal</td>
<td>Factor XIII deficiency</td>
<td>Factor VII deficiency</td>
</tr>
<tr>
<td>APTT Abnormal</td>
<td>Factor VIII, IX, XI, XII deficiency</td>
<td>Factor I, II, V, X deficiency</td>
</tr>
<tr>
<td></td>
<td>Factor VIII inhibitor</td>
<td></td>
</tr>
</tbody>
</table>

Hemophilia A

- Deficient or absent FVIII
- FVIII levels
  - <1: Severe
  - 1-5: Moderate
  - >5: Mild
- Treatment: Factor VIII concentrates
  - Recombinant: Safest
  - Virus inactivated, plasma derived
**Inhibitors to FVIII**

- Bethesda units
- <5 BU
  - Increased dose of FVIII
- >5 BU
  - Factor VIIa
  - Activated Prothrombin Complex Concentrates (FEIBA)
  - Porcine FVIII

**Hemophilia B**

- Factor IX deficiency
  - Recombinant Factor IX
  - Virus inactivated, Plasma derived Factor IX
- Patients with Inhibitors
  - Factor VIIa

**DIC**

- Disseminated Intravascular Coagulation
- Increased: PT, PTT, TT, FDP’s, D-dimers
- Decreased: Platelets, Factor levels
- Treat underlying cause
- Maintain hemostatic function
  - RBC’s, Plasma, Cryoprecipitate
  - Platelets (except in cases of severe thrombosis)
Transfusion Reactions

Categories

- Acute (<24hrs) or Delayed (>24 hrs)
- Immunologic (Ag-Ab) or Non-immunologic
- Intravascular or Extravascular Hemolysis
- Table in Technical Manual
- Recognize signs and symptoms

Acute HTR - Immune

- ABO incompatible RBC’s
- Patient misidentification most common cause of ABO incompatibility
- Occurs within minutes of start of infusion
**Acute HTR**

- IgM or complement-fixing IgG
- ABO, Vel, Kidd
- Fever, chills, hypotension, renal failure, DIC, excessive pain and/or bleeding at infusion site
- Interaction of Complement, Kinin and Coagulation systems

**Acute HTR**

- Treatment
  - Stop transfusion
  - Treat hypotension and promote adequate renal blood flow
  - Monitor for/support DIC
  - Medical management may be complicated and require aggressive interventions
- How could this have been prevented?

**Transfusion Reactions**

- Acute Non-immune Mediated Hemolysis
  - Heating, Freezing, IV solutions

- Transfusion-Associated Sepsis
  - Platelet testing

- Febrile Nonhemolytic Reactions
  - Common, but initial symptom is Fever
Transfusion Reactions

- Urticarial
  - Only reaction where the transfusion can be stopped and restarted
- ACE Inhibitor hypotension
  - Inhibited metabolism of Bradykinin
- Know causes, treatment, and prevention

Anaphylactic Reactions

- Occurs rapidly
- Causes
  - IgA deficiency, Anti-IgA
- Treatment
  - Epinephrine
- Prevention
  - IgA-deficient components
  - Washed RBCs and platelets
  - Autologous (Transfusing what product would have prevented this reaction?)

Transfusion-Related Acute Lung Injury (TRALI)

- Definition
  - Acute onset
    - During transfusion or within 6 hrs
  - Hypoxemia
  - Bilateral lung infiltrates
  - No circulatory overload (TACO)
- Risk factors
  - Donor with multiple pregnancies?
Transfusion-Related Acute Lung Injury (TRALI)

- Severity of distress is usually disproportionate to volume of blood infused
- Causes
  - Antibody to HLA or neutrophil antigen
  - Transfusion of cytokines
- Treatment and prevention
- Do not use donor for plasma-containing components

Other Acute Complications

- Transfusion-Associated Circulatory Overload (TACO)
  - Similar symptoms to TRALI
- Metabolic Reactions
  - Citrate toxicity
  - Hypothermia
  - Hyperkalemia
- Air embolism

Evaluation of Suspected Acute Transfusion Reaction

- Role of clinician
- Role of laboratory
- Comments about DAT
  - If transfused incompatible cells have been coated with antibody, but not destroyed, DAT will be positive (mixed field)
  - If RBCs have been rapidly destroyed, DAT may be negative
  - Non-immune hemolysis causes hemoglobinemia, but negative DAT
**Delayed Immunologic:**
*Alloimmunization*

- Immune response to foreign antigens on RBC, or WBC and platelets (HLA)
- Weeks to months after transfusion
- Antibody may fall to undetectable levels (esp. Kidd)
- Anamnestic response (within hours to days)
- DAT will become positive first
  - May need to elute Ab off RBCs to identify
- Prior to antibody being detected in serum, crossmatch may be compatible

**Delayed HTR**

- Usually only causes delayed serologic reaction (no clinical symptoms) occasionally, may see hemolysis
- Most common antibodies – Kidd, Kell, Duffy, E, c, D
- If DHTR suspected, obtain sample & test for unexpected alloantibody on RBCs and in serum & compare with previous results

**Transfusion-Associated Graft-vs-Host Disease (TA-GVHD)**

- Rare, usually fatal - no effective treatment
- Donor lymphocytes engraft in the recipient, proliferate, and attack host tissue.
- Symptoms usually appear within 10-12 days of transfusion
- Usually see refractory pancytopenia with bleeding and infectious complications
- Patient risk factors
- Prevention – Irradiation
- First degree relatives: Homozygous HLA infused into Heterozygous HLA
### Post-transfusion Purpura

- Abrupt onset of severe thrombocytopenia (<10,000/µL) following blood transfusion in a previously pregnant or transfused patient
- Most patient cases have platelets that lack the HPA-1a (PIA1) antigen, and form an antibody directed to this antigen
- Antibody destroys HPA-1a positive donor platelets, but also the patient's own HPA-1a negative platelets (mechanism unknown)
- Random platelet transfusions are contraindicated

### Iron Overload

- One red cell unit contains 200 mg iron
- Chronically transfused patients at risk
- Storage first in reticuloendothelial system, then parenchymal cells
- Iron deposits interfere with heart, liver, and endocrine glands
- Threshold for clinical damage: lifetime exposure to 50-100 units (maybe even as low as 25) of red cells in a non-bleeding person
- Treatment: Iron-chelating agents, "fresh" blood

### Records of Transfusion Complications

- Interpretation of the evaluation shall be recorded in the patient’s medical record
- Maintain records indefinitely
- Review of previous records
- Notification to collecting facility
- Fatalities – report to FDA
Hemolytic Disease of the Fetus and Newborn (HDFN)

William Turcan, MT(ASCP)SBB
Monica LaSarre, MT(ASCP)SBB

HDFN Prerequisites

- Mom lacks antigen (exposed through pregnancy or transfusion)
- Fetus possesses antigen; inherited from father
- Mom has formed an IgG antibody
  - Sensitization depends on:
    • Recognition of foreign antigen
    • Responder
    • Antigen is immunogenic
    • Amount of bleed
    • ABO compatibility

Antibodies and HDFN

- Is the antibody IgG?

- Is the antigen well developed at birth?
**Bilirubin**

- Fetal bilirubin is processed by maternal liver before birth
- Infant liver is immature at birth
  - Cannot conjugate amount of bilirubin that results from destruction of antibody-coated RBCs
- Unconjugated bilirubin is toxic to CNS
  - Kernicterus

**HDFN Big Problems**

- Newborn
  - Excess unconjugated bilirubin
  - Kernicterus
- Fetus
  - Severe anemia
  - Cardiac failure and generalized edema
  - Hydrops fetalis

**Complications of HDFN**

- Rising levels of unconjugated bilirubin biggest risk
  - Decision to perform exchange transfusion driven by bilirubin levels
- CNS damage caused by:
  - Prematurity
  - Acidosis
  - Hypoxia
  - Hypoalbuminemia
**HDFN Categories**

- Rh HDFN
  - Anti-D alone, or in combination with
  - Anti-C or anti-E
- “Other” HDFN
  - Other antigens in Rh system
    - Anti-c
  - Antigens in other systems
    - Anti-K
- ABO HDFN
  - Anti-A,B in group O woman

**ABO vs. Rh HDFN**

<table>
<thead>
<tr>
<th>ABO-HDFN</th>
<th>Rh-HDFN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most common</td>
<td>Immune exposure (2nd child)</td>
</tr>
<tr>
<td>Least severe</td>
<td>Very strong + DAT</td>
</tr>
<tr>
<td>Can affect 1st baby</td>
<td>May need exchange transfusion</td>
</tr>
<tr>
<td>Weak-neg. DAT</td>
<td></td>
</tr>
<tr>
<td>Occurs in “O” moms</td>
<td></td>
</tr>
<tr>
<td>Slight rise in bilirubin (phototherapy)</td>
<td></td>
</tr>
</tbody>
</table>

**HDFN**

- Prenatal Testing
  - Patient history (Has this Ab caused problems before?)
  - Testing on mom (Antibody Titers)
  - Most probable phenotype of most probable father
  - Amniocentesis (Liley Graph)
- PUBS (Cordocentesis)
- Intrauterine transfusion (exchange)
**HDFN**

- Rh Immune Globulin
  - Indications
  - Antenatal (28 weeks or after invasive procedure)
  - Postpartum
  - Rosette test (semi-quantitative)
  - Kleihauer-Betke (acid-elution) Stain (quantitative)
    - Calculations & RhIG dosage

- Exchange transfusion
  - Indications, beneficial effects, component requirements, calculations, methods

**Anti-G**

- Reacts with cells that are D and/or C positive
- Patient can have a mixture of Anti-D, Anti-C and Anti-G

- If Anti-D is not present, RhIG is indicated

**Test Tip #1**

What blood type of FFP should be used for a plasma exchange in a patient that is O positive?

A. O  
B. A  
C. B  
D. AB
**Test Tip #1**
What blood type of FFP should be used for a plasma exchange in a patient that is O positive?

A. O  All answers are clinically correct
B. A  O is the BEST answer
C. B
D. AB

**Test Tip #2**
Which of the following phenotypes would be found the least in the general population?

A. Fy(a-b-), Jk(a+b-)
B. E-c-K-
C. M+N-S-s+
D. H-

**Test Tip #2**
Which of the following phenotypes would be found the least in the general population?

A. Fy(a-b-), Jk(a+b-)
B. E-c-K-
C. M+N-S-s+
D. H-  Read the question and all four choices BEFORE you attempt to answer
Test Tip #3
• Anti-Fy\(^a\) will react the strongest with which of the following cells?
  • A. Fy(a+b-), Kp(a+)
  • B. Fy(a+b-), Js(a+)
  • C. Fy(a+b+)
  • D. Fy(a-b-)

Many times you can eliminate two answers quickly, but the remaining two answers are very close

Test Tip #3
• Anti-Fy\(^a\) will react the strongest with which of the following cells?
  • A. Fy(a+b-), Kp(a+)
  • B. Fy(a+b-), Js(a+)

Test Tip #3
• Anti-Fy\(^a\) will react the strongest with which of the following cells?
  • A. Fy(a+b-), Kp(a+)
  • B. Fy(a+b-), Js(a+)
  - White, Fy\(^a\)Fy\(^a\) Homozygous genotype
  - Black, Fy\(^a\)Fy Heterozygous genotype
Dedication

SBB/BB Exam Review

Lab Math Problems
LeeAnn Walker, MEd, MT(ASCP)SBB
Immucor, Inc.
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Lab Math

• Refer to Study Guide for
  – Formulae
  – Helpful hints
  – Practice Problems
  – Answer discussions
Problem 2

• A unit of FFP contains 0.6 units/mL of Factor VIII in 250 mL. When the cryoprecipitate is made from this unit, it contains 10 units/mL in 12 mL. What is the Factor VIII yield as a percentage of the original Factor VIII?

\[(\frac{10 \text{ units/mL} \times 12 \text{ mL}}{0.6 \text{ units/mL} \times 250 \text{ mL}})\]
\[= \frac{120 \text{ units}}{150 \text{ units}} = 80\%\]

Problem 3

• In a population of 6129 individuals, 1787 individuals reacted 3-4+ and 3039 individuals reacted 1+ with anti-Q. What is the percentage of individuals with the negative phenotype?

\[4826 \text{ are Q+; 1303 are Q negative}\]
\[= \frac{1303}{6129} = 21.2\% \text{ are Q negative}\]

Problem 6

• A severe hemophiliac is scheduled for surgery tomorrow. His physician wants to increase his Factor VIII level to 75% before the procedure. His hematocrit is 40% and his plasma volume is 3000 mL. How many bags of cryoprecipitate should be given?

\[\frac{[3000 \text{ mL} \times (0.75 - 0)]}{80 \text{ U/bag}} = 28 \text{ bags}\]
**Problem 10**

- An acid elution stain on a post-partum specimen shows 2.5% fetal cells present in the maternal circulation. How many vials of RhIg must be given?
  - \(2.5 \times 50 = 125\) mL WB FMH
  - \(125 / 30 = 4.2\) or 5 vials RhIg

**Problem 11**

- A male patient weighing 190 lbs. has lost an estimated 1900 mL of blood following an auto accident. What percentage of his total blood volume has been lost?
  - \(190 \text{lb} / 2.2 \text{lb/kg} = 86.4 \text{kg}\)
  - \(86.4 \text{kg} \times 75 \text{mL/kg} = 6480 \text{mL total blood volume}\)
  - \(1900 \text{mL} / 6480 \text{mL} = 29\%\) of total blood volume

**Problem 17**

- Given the following information, determine the number of FTEs required for the workload:
  - Vacation/year: 3 weeks
  - Ave. sick leave/year: 5 days
  - Holidays/year: 6 days
  - Continuing Education: 4 days
  - Productivity: 75%
  - Annual Workload: 800,000 units (minutes/year)
Problem 17, cont.

• # hours worked/year:
  – 46 weeks/year x 40 hours/week = 1840 hrs/year

• # productive minutes/year:
  – 1840 hours/year x 45 min/hour = 82800 min/year

• # FTEs
  – 800,000 units / 82,800 min/year = 9.66 FTE

More problems 1...

• A 70 kg man has a 40% hematocrit. What volume of plasma is needed for a one-volume plasma exchange?
  – 70 kg x 75 mL/kg = 5250 mL blood volume
  – 5250 mL x 0.60% = 3150 mL plasma

More problems 2...

• 500 donors must be antigen-typed using a rare antisera. Two drops of antisera are required for each test. If the antisera can be diluted 1:8, how much neat serum is needed for all testing?
  – 500 tests x 2 drops/test = 1000 drops
  – 1000 drops/8 = 125 drops
More problems 3...

- To protect the lab staff from HBV infection, it is recommended that the Hepatitis B vaccine be given to all employees. You have 20 techs who will need 3 injections each at $15 per injection. Which is more cost effective: testing all employees first ($10/test) to determine those who are already positive (5% rate) or vaccinating all employees?

More problems 3...

- 20 techs, 3 injections, $15 each
  - Cost of vaccination:
    20 techs x 3 shots/tech x $15/shot = $900
  - Cost of testing:
    20 techs x $10/test = $200
    5% positive = 1 tech
    * Total cost:
      19 x $45 = $855
      + cost of testing 200
      $1055

More problems 4...

- A patient with anti-c, anti-E, anti-K and anti-Fy^a requires 4 units of blood for surgery tomorrow. How many units would you need to screen to find these units?
  - cE neg = 0.19; K neg = 0.90; Fya neg = 0.35
    % negative for all = 6.0%
    6/100 = 4/x; x = 400/6
    Need to screen 67 units
More problems 5...

• WB donor has platelet count of 220,000 and donates 500 mL WB. The platelet concentrate prepared contains $8.5 \times 10^{10}$ platelets. What is the platelet yield?

- $220 \times 10^3 \text{ plt/ul} \times 500 \text{ mL} \times 1000 \text{ ul/mL}$
  $= 1.1 \times 10^{13}$ platelets
- $0.85 \times 10^{11} / 1.1 \times 10^{11} = 77\%$

SBB/BB Exam Review

THE SBB EXAM

Resources
Preparation Guide
Testing Strategies

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Immucor, Inc.
Norcross, GA

Resources

• Know current AABB Standards
  – If current edition recently implemented, know differences from previous edition

• Comprehensive study of Technical Manual: each chapter, each method section. Extra chapter references, suggested readings

• Blood Transfusion Therapy: A Physician’s Handbook
Review Courses

- Carefully study AABB SBB/BB Exam Review Study Guide material and go beyond…
  - GWU SBB Review course
  - Last Chance Review
    - Each winter; cwong@giveblood.org; 713-791-6201
  - Some regional blood bank meetings
    - check web sites

Reference Lists

- SBB Exam Reference List
  - www.ascp.org
    - Reading List has links to purchase references
  - Check on internet sources, i.e. Amazon
- Blood Banking Reference List
  - www.aabb.org/marketplace
  - Can search by keyword

Study Plan

- Consistent study and review time
  - Make an action plan and timeline
    - What are your weak areas?
    - What do you want to do to prepare?
    - Time requirements for each part of review
  - Stick to your plan!
  - Final review
    - Organize time according to category % and weak subjects
Study Plan

- Make notecards, review questions, comparative charts
- Compile all lab math formulas, genetics equations
- Practice exams, problems, “brain dump”
  – More on that later…

Study Plan

- Compile all Blood Group information
  – genetics
  – biochemistry
  – antigen
  – antibodies
  – highlights, unique points
- Compile serological testing information
  – procedure
  – quality control
  – appropriate use
  – results

Study Plan

- Compile component information
  – collection & preparation
  – storage requirements
  – expiration dates
  – content
  – quality control
  – appropriate use
Getting in the Door

• Admission Letter
• 2 valid IDs
  – Name must match admission letter
• Palm vein image
  – To establish your account
• Say Cheese!
  – Picture
  – Audio/video
• Testing center will provide:
  – White paper or white board.
  – Any required panel master lists.
• You may use a non-programmable calculator.
• No cell phones allowed!

Test Strategy: The “Brain Dump”

• Make study notes at the exam site before starting exam
• Write down all memorized facts
  – Blood group %s
  – Formulas
  – Techniques
  – Effects of chemical treatment
  – Etc…
• Can sometimes request more paper during exam

Taking the Exam

• Computer use and problems
• Read instructions before arriving at the test site
  – www.ascp.org
• 2.5 hours for 100 questions
  – Timing does not start until you click on the ‘Start Exam’ button
• 10 questions will not be graded.
  – New questions to be evaluated
• Must give best guess before next question will be given.
**Exam Categories**

- Blood Products
- Blood Group Systems
- Immunology
- Laboratory Operations
- Physiology/Pathophysiology
- Serology
- Transfusion Practice

**Taxonomy Levels**

- Level One
  - Recall - remember facts
- Level Two
  - Interpretive Skills - Use facts to interpret
- Level Three
  - Problem Solving - Use facts to interpret and resolve problems

**Computer Adaptive Testing**

- Exam Categories
  - Computer will give fixed number of questions from each category
  - Computer does not give more or less, regardless of performance
- Question Difficulty Rating:
  - Taxonomy Level
  - Amount of “SBB ability” needed to achieve the correct answer
Computer Adaptive Testing

• Fixed number of questions from each category
• Computer adapts exam to your performance
• Chooses each specific category question by difficulty
• Estimates your “SBB ability” and selects questions with matching difficulty

How does computer estimate “SBB ability”? 

• Student answers “a few” questions
• Computer makes rough estimate of ability based on those answers
• Computer gives student a question equal to that ability

How does computer estimate “SBB ability”? 

• Answers correctly, ability is boosted
  – Next question is chosen at higher difficulty
• Answers incorrectly: ability is maintained
  – Next question is chosen at same difficulty
  – Second and subsequent incorrect answers lower ability and question difficulty
In summary,

- Computer makes rough estimate of ability
- Each question answered boosts or lowers estimated ability
- With each question answered, estimate of ability becomes more statistically correct
- Passing score range is 400-999

Example

- Student answers ten questions
- Computer estimates ability at 450
- Computer chooses next question at a difficulty level of 450

Example, continued

- Student answers correctly
- Computer adjusts ability and chooses next question at a difficulty level of 460
- Student answers incorrectly
- Computer maintains ability and chooses next question at same difficulty level
How is the Exam Scored?

- The score is based on:
  - the combined level of difficulty of all 90 graded questions AND
  - total number correct answers
- The higher the difficulty of the test, the fewer questions need to be answered correctly to have a minimum passing score (400)

Considering “Tricking” the Computer?

- Could you answer all questions incorrectly, get a very easy test, then correctly answer questions in review phase?
  - If too many are answered incorrectly, exam becomes non-adaptive
  - So questions are at minimum difficulty and a very high number must be correct to pass

More Test Strategy

- Do the very best you can as you answer every question
  - this gives you a test with high difficulty
  - a difficult test requires fewer correct answers
- Answers corrected during review phase
  DO boost final score so mark questions for review if unsure
Reviewing

• At end, can review all questions or only marked questions
  – review all questions if more than 30 minutes
  – review marked questions if less than 30 minutes
• When reviewing questions
  – revise ONLY if you are positive of the correct answer
  – this assures you have answered each question to the best of your ability

If you do NOT pass the first time:

• DO NOT GIVE UP!!!
• Call ASCP for help formulating a study plan based on subtest scores.
• Don’t Delay!
  – Register for the next exam period.
• Make an action plan for studying.
• You can take same exam by same eligibility route up to 5 times.

ASCP Contact

For FAQ, Test Content, Scoring, and Study Plans

Website
www.ascp.org
A word on Registering...

• Do NOT take exam during the last two weeks of the three month exam period
• Example:
  – If you are unsuccessful in the last two weeks of the first quarter, you can't take the test until fourth quarter
  – If you are unsuccessful earlier in the first quarter, you can re-register and take the test in the third quarter

GOOD LUCK!!!

You can do it…