UNIVERSITY OF JOHANNESBURG

PROGRAM	:	*BIOMEDICAL TECHNOLOGY*
MODULE	:	**Blood Transfusion Technology**
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TOTAL MARKS	:	180

EXAMINER	:	MRS J PIENAAR
MODERATOR	:	MRS F KLINKERT
NUMBER OF PAGES	:	17 PAGES

INSTRUCTIONS : QUESTION PAPER MUST BE HANDED IN

REQUIREMENTS : EXAM SCRIPT/S AND 1 MCQ CARD

1. Do section A on the MCQ card.
2. Do section B and C in the exam script.

INSTRUCTIONS TO CANDIDATES:

1. THIS PAPER CONSISTS OF 3 SECTIONS.
2. EVERY SECTION MUST BE ANSWERED IN THE EXAMINATION ANSWER SCRIPT/S OR MCQ CARD PROVIDED.
3. THIS QUESTION PAPER MUST BE RETURNED WITH YOUR EXAMINATION ANSWER SCRIPT.
4. YOU MAY USE A CALCULATOR.

SECTION A: MCQ

INSTRUCTION: CHOOSE ONLY ONE CORRECT ANSWER AND MARK ON THE MULTIPLE CHOICE (MCQ) ANSWER CARD:
(1 mark per question).

1. Bombay phenotype individuals…

   a) Have A and B antigens on their red cell membranes
   b) Have A, B, and H antigens on their red cell membranes
   c) Have A, B and H antibodies in their serum
   d) Lack all ABO antibodies in their serum
   e) Are universal recipients

2. What is the purpose of the indirect antiglobulin test?

   a) *In vitro* coating of red cells by abnormal IgG antibodies
   b) *In vivo* coating of red cells by abnormal IgG antibodies
   c) Paternal antibodies in HDN
   d) Foetal antigens
   e) Maternal antigens

3. Which ONE of these infectious agents is NOT tested for in blood products?

   a) Hepatitis C antibody
   b) Hepatitis B
   c) Gonorrhoea
   d) HIV
   e) Syphilis

4. How do antibodies destroy red cells in the body?

   a) They directly attack red cells
   b) They activate the complement cascade
   c) Macrophage recognition of red cell bound antibody
   d) All of the above are correct
   e) B and C

5. At which temperature should fresh frozen plasma be stored at?

a) 22 ± 2 °C
b) 4 ± 2 °C
c) 30 ± 2 °C
d) Above 37 °C
e) Below -30 °C

6. Concerning non-conformances, the following practices must be followed, EXCEPT:

a) They must be properly investigated
b) A root cause for the problem must be established
c) It is not necessary to set a time limit for resolution
d) A person must be assigned responsibility for resolution
e) Management must ensure that the problem is properly and timeously resolved

7. What is the purpose of the reverse grouping test?

a) To check which antigens are present on the red blood cells
b) To check which antibodies are present in the serum
c) To check which antigens are present in the serum
d) To check which antibodies are present on the red blood cells
e) To check agglutinins within the red blood cells

8. All below are TRUE of the Weak D antigen EXCEPT:

a) The Weak D antigen appears to be a weaker form of the D antigen
b) May only be detectable by enzyme techniques
c) May stimulate anti-D if transfused into Rh negative individual
d) Weak D patients are treated as Rh negative recipients
e) Weak D patients are treated as Rh positive donors

9. Which of the following characteristics *best* describe Duffy antibodies?

a) IgM, naturally occurring, does not cause HDN
b) IgM, naturally occurring, causes HDN
c) IgG, *in vitro* haemolysis, cause haemolytic transfusion reactions and HDN
d) IgG, *in vitro* haemolysis, does not cause haemolytic transfusion reactions
e) IgM *in vitro* haemolysis, cause haemolytic transfusion reactions

10. The following are examples of pyrogenic materials (cause pyrogenic transfusion reactions) EXCEPT:

a) Dried blood
b) Dried protein
c) Bacteria
d) Products of metabolic growth of bacteria
e) Incorrect ABO blood group

11. Which ONE of the following transfusions is likely to cause *intravascular* haemolysis?

a) Group O blood to group A recipient
b) Group B blood to group O recipient
c) Group O blood to group AB recipient
d) Rh-positive blood to a Rh-negative donor
e) All of the above

12. The following is true about blood group A EXCEPT:

a) It can be divided further into two main subgroups called A_1 and A_2
b) The A^1 gene is dominant to the A^2 gene
c) Individuals of group A_1 have less A antigen sites on each of their red cells compared with group A_2 individuals
d) Both A^1 and A^2 genes are co-dominant when present with a B gene
e) Both A^1 and A^2 genes are dominant when present with an O gene

13. All are aspects of the document control policy (i.e. defines how documents are controlled) EXCEPT:

a) They are uniquely identified
b) They are validated
c) They are approved
d) There is no need to review them annually
e) They are issued

14. What immunoglobulin type causes Warm Autoimmune Haemolytic Anaemia?

a) IgM
b) IgA
c) IgG
d) IgE
e) IgD

15. When the allelic genes are alike, that person is said to be:

a) Heterozygous
b) Hemizygous
c) Recessive
d) Dominant
e) Homozygous

16. Pre-treatment of red blood cells with enzymes…

a) Increases the charged particles
b) Causes the antigen sites to become more exposed
c) Digests the red blood cells membrane exposing the antibodies
d) Preserves antigenic sites
e) Does not work with the ABO antigens as they are glycoproteins

17. When is the secondary (anamnestic) response produced?

a) When an antibody invades the body for the first time
b) When an antigen invades the body for the first time
c) When there has been an exposure of a second dose of the same antigen
d) When two antigens invade the body simultaneously
e) None of the above

18. At which temperature should platelets be stored at?

a) 22 ± 2 °C
b) 4 ± 2 °C
c) Above 37 °C
d) Below -30 °C
e) All of the above are incorrect

19. Which of the following is TRUE of post transfusion purpura?

a) PTP is defined as thrombocytopenia arising normally 5-12 days following a transfusion of a red cell/platelet concentrate product.
b) It is associated with the presence of antibodies directed against the human platelet antigen systems.
c) Platelet specific antibody is most frequently produced by women as a result of immunization via a previous pregnancy.
d) All of the above
e) None of the above

20. What are the blood grouping phenotype results for the following Rh phenotype: R_1R_1?

a) Positive for anti-D, anti-C, and anti-e
b) Positive for anti-D, anti-c, and anti-E
c) Positive for anti-c, anti-E, and anti-e
d) Positive for anti-D, anti-c, anti-E, and anti-e
e) Positive for anti-C, anti-c, anti-E, and anti-e

21. Which of the following facts are TRUE of complement proteins?

a) If the complement cascade goes to C9, the macrophages of the reticuloendothelial system will remove and destroy the coated red cells.
b) If the complement cascade goes to C3, direct lysis will occur due to the membrane attack complex.
c) Can be destroyed by heating at 56°C or above for 30 minutes.
d) The complement proteins are not inactivated by the presence of calcium-containing anticoagulants
e) Complement in EDTA-plasma can be detected by AHG tests.

22. In the investigation of a transfusion reaction, all of the following must be requested EXCEPT:

a) Urine sample
b) Post transfusion blood sample
c) Pre-transfusion blood sample
d) Return all used/unused units of blood or blood products
e) Request form if more blood/blood products are needed

23. Which one of the following statements is TRUE about the Kell blood group system?

a) Has two main antithetical antigens, the K (Kell) and k (Cellano)
b) Anti-K and anti-k are IgG immune antibodies
c) React best at 37 degrees Celsius by AHG and enzyme techniques
d) Are clinically significant and can activate complement
e) All the above

24. The following is TRUE concerning Rh positive individuals:

a) They are all homozygous dominant (DD)
b) They are either homozygous recessive (dd) or heterozygous (Dd) for this trait.
c) They are either homozygous dominant (DD) or heterozygous (Dd) for this trait.
d) They are all homozygous recessive (dd)
e) None of the above

25. Regarding the technical requirements for quality of results, all reagents must adhere to the following EXCEPT:
a) Meet minimum requirements.
b) Be stored correctly.
c) Manufacturer's directions must be followed.
d) Every vial of red cells should be inspected for icterus
e) Records of daily QC should be kept.

Questions 26 - 30. The following statements refer to Compatibility Testing.

The cross-match is a test between the 26_____ serum and the 27_____ red cells to show that no antibodies are present in the patient's serum that will cause either a frank transfusion reaction (IgM mediated 28_____ haemolysis) or premature destruction of the transfused cells 29_____ mediated 30_____ haemolysis).

a) extravascular
b) intravascular
c) IgG
d) patient's
e) donor's

For the following questions (31-40), choose either True (a on the MCQ card) or False (b on the MCQ card).

31. *True or False:* The sugars responsible for the A, B and O blood group antigen structures are N-acetyl-galactosamine, D-galactose and L-fucose respectively.

a) True
b) False

32. *True or False:* For the Rh system the D antigen is considered the most immunogenic with most reports of HDN associated with anti-D.

a) True
b) False

33. *True or False:* The dosage effect seen in the Kidd system means individuals with the phenotype Jk(a+b-) have more Jk^a antigen on the red cell surface than phenotype Jk(a+b+).

a) True
b) False

34. *True or False:* The secondary immune response involves the production of mainly IgM antibodies.

a) True
b) False

35. *True or False:* ABO antibodies are mainly IgM, can bind complement and react optimally at 37°C.

a) True
b) False

36. *True or False:* Parents with blood group genotypes OO and AA will have all blood group A children.

a) True
b) False

37. *True or False:* The subgroup A_2 have more A antigen sites on the red cell compared to A_1.

a) True
b) False

38. *True or False:* If anti-c is detected in a patient who requires 1 unit of red cells, the donor unit must be antigen positive.

a) True
b) False

39. *True or False:* Anti-D is predominantly IgG class, can cause extravascular haemolysis and reacts optimally at 37°C.

a) True
b) False

40. *True or False:* Individuals with the phenotype Fy(a-b-) are protected from *Plasmodium vivax*.

a) True
b) False

SECTION A SUBTOTAL: 40

SECTION B: SHORT AND LONG QUESTIONS

INSTRUCTION: ANSWER THE QUESTIONS FOR SECTIONS B AND C IN AN EXAM BOOK (PLEASE MARK EACH SECTION).

QUESTION 1

Define the following terms:

1.1. Allele, allelomorph or allelic gene (2)

1.2. Antigen (1)

1.3. Complement (1)

1.4. Elution (1)

1.5. Immunoglobulin (2)

1.6. Intravascular haemolysis (1)

1.7. Recessive gene (1)

1.8. Quality Assurance (1)

[10]

QUESTION 2

Concerning antibody production, describe the *primary immune response*. **[7]**

QUESTION 3

Concerning the major factors affecting the primary stage of red cell agglutination, describe:

R*ed cell (antigen) to serum/plasma (antibody) ratio*: **[3]**

QUESTION 4

Answer the following questions on *extravascular lysis*:

4.1. Which RES organ recognises and removes red cells coated with C3b? (1)

4.2. Which RES organ/s recognise and remove red cells coated with both IgG and C3b? (1)

4.3. Name the two factors that affect the rate of red cell destruction in extravascular haemolysis. (2)

[4]

QUESTION 5

Show all possible offspring **phenotypes** for the following parents (write in your scripts):

PHENOTYPES OF PARENTS		POSSIBLE PHENOTYPES OF OFFSPRING
PARENT 1	PARENT 2	
A_1	A_2	5.1:
A_1B	A_2B	5.2:
A_2	O	5.3:
A_2B	B	5.4:

[12]

QUESTION 6

6.1. Explain, in detail, how the **B antigen** is made, giving particulars about all the genes and the biochemical components involved. (5)

6.2. Name the enzyme that is made from the A gene. (1)

6.3. Which blood group has the most H antigen and which blood group has the least (excluding Bombay); explain why in each case. (2)

[8]

QUESTION 7

7.1. *Missing antigens* cause anomalous ABO grouping results. Supply one (1) example of a cause of unexpected negative reactions or very weak expression of antigens. (1)

7.2. Describe the Bombay blood group, including information about the genotype and substances produced, as well as the resulting antigens and antibodies. (4)

[5]

QUESTION 8

8.1. Please complete the following table on Rh nomenclature (in your scripts): (6)

Haplotype gene complex	Shorthand nomenclature
8.1.2	r^y
Cde	**8.1.2**
8.1.3	r
CDE	**8.1.4**
cDE	**8.1.5**
8.1.6	R_0

8.2. Regarding the mechanisms of the "Weak D", describe the **D Mosaic**. (4)

[10]

QUESTION 9

9.1. Tabulate the blood grouping reactions, phenotype and genotype of the Kidd blood group system. (½ x 12 = 6)

9.2. Discuss why the dosage effect occurs in Kidd antigens, and give the example relating to the Kidd antigens. (2)

[8]

QUESTION 10

10.1. Explain, in detail, the *principle* of the Kleihauer-Betke test. (3)

10.2. Regarding postnatal diagnosis of HDN, list the tests done on the baby's cord blood specimen. (5)

[8]

QUESTION 11

11.1. Draw and fully label the following drug induced autoimmune haemolytic anaemia mechanism: (6)
Immune complex mechanism

11.2. Answer the following questions on *warm autoimmune haemolytic anaemia*:

11.2.1. What immunoglobulin type is **commonly** responsible for this disease? (1)

11.2.2. What red cell feature is commonly seen on the peripheral blood smear? (1)

11.2.3. Name the common aetiology/cause of the autoantibodies in this disease. (1)

[9]

QUESTION 12

12.1 Draw and describe the following antibody detection method:
Antigen Sandwich assay (4)

12.2. List, in order, the steps involved in PCR testing of blood donations. (4)

[8]

QUESTION 13

13.1. Concerning *non-immune* complications of blood transfusion, describe the following metabolic effect that may be seen: (3)
Haemosiderosis

13.2. What is *PTP*, what causes it and how does this arise? (6)

[9]

QUESTION 14:

14.1. Concerning the factors that affect pH and gas exchange in stored platelets, describe the effects of *Mixing* and *Temperature*. (4)

14.2. List the three (3) main *fractionated* plasma products produced. (3)

[7]

QUESTION 15

List the necessary components/aspects that are needed to ensure a good quality assurance programme. **[6]**

SECTION B SUBTOTAL: 114

SECTION C: APPLICATION QUESTIONS

INSTRUCTION: ANSWER THE QUESTIONS FOR SECTIONS B AND C IN AN EXAM BOOK (PLEASE MARK EACH SECTION).

QUESTION 1

Using the following antigram, identify the antibody(ies) that may be present in the serum from the following 5 patients P; Q; R; S and T (all blood group O):

No	Rh	OTC	Cw	C	D	E	c	e	M	N	Mg	S	s	P_1	Lua	Lub	Lea	Leb	K	k	Kpa	Kpb	Wka	Fya	Fyb	Jka	Jkb	Sda
1	R_1wR_1	5304	+	+	+	−	−	+	+	+	−	−	+	++	−	+	−	+	−	+	+	+	−	−	+	+	−	+
2	R_1R_1	3213	−	+	+	−	−	+	+	−	−	+	+	++	+	NT	+	−	−	+	−	+	−	+	+	−	+	+
3	R_2R_2	4095	−	−	+	+	+	−	−	+	−	+	+	+++	−	NT	+	−	−	+	−	+	−	+	+	+	−	±
4	R_2R_2	2395	−	−	+	+	+	−	−	+	−	−	+	++	−	+	−	+	−	+	−	+	−	+	−	+	+	±
5	r'r	5659	−	+	−	−	+	+	−	+	−	−	+	+	−	+	−	−	−	+	−	+	−	+	+	+	−	±
6	r''r	5682	−	−	−	+	+	+	+	+	−	+	−	−	+	+	−	+	−	+	−	+	−	+	+	+	+	++
7	rr	1944	−	−	−	−	+	+	+	−	−	+	+	+	−	+	+	−	+	+	−	+	−	+	+	+	+	+
8	rr	4326	−	−	−	−	+	+	+	+	−	−	+	+++	−	NT	+	−	−	+	−	+	−	+	−	−	+	++
9	rr	2827	−	−	−	−	+	+	+	−	−	+	−	+++	−	NT	−	+	+	+	−	+	−	−	+	−	+	+
10	R_1R_2	5045	−	+	+	+	+	+	+	−	−	+	−	+	−	+	+	−	−	+	−	NT	−	+	−	+	−	++

Specification: single donor group O plasma reduced blood (haematocrit 60–70%) in CPDA-

	PATIENT P		PATIENT Q	PATIENT R	PATIENT S	PATIENT T	
	ENZ @ 37^{0}C	AHG @ 37^{0}C	AHG @ 37^{0}C	AHG @ 37^{0}C	SALINE	ENZ @ 37^{0}C	AHG @ 37^{0}C
1	4	4	4	4	0	0	0
2	4	4	4	4	4	0	4
3	0	0	4	4	4	0	4
4	0	0	0	4	0	0	4
5	4	4	4	4	0	0	4
6	0	0	4	0	0	0	4
7	0	0	4	4	4	4	4
8	0	0	0	4	4	0	4
9	0	0	4	0	0	4	0
10	4	4	0	0	4	0	4

1.1. PATIENT P =

1.2. PATIENT Q =

1.3. PATIENT R =

1.4. PATIENT S =

1.5. PATIENT T =

[6]

QUESTION 2

The previous patients P; Q; R; S and T each require **2 units** of blood. Which units of blood would you select for cross-matching against each patient, bearing in mind the previous antibody/ies identified? **(WARNING: YOU OBVIOUSLY CANNOT SELECT THE SAME UNIT OF BLOOD MORE THAN ONCE).**

UNIT NO	Rh	M	N	S	s	P_1	Lu^a	Lu^b	Le^a	Le^b	K	k	Fy^a	Fy^b
101	R_1R_z	+	+	+	-	+	-	+	-	-	-	+	+	+
102	R_1R_2	+	+	+	+	+	+	+	-	-	-	+	-	-
103	R_1R_2	-	+	+	+	+	-	+	-	+	-	+	-	+
104	R_1R_2	+	-	+	-	+	-	+	+	+	+	+	+	+
105	R_1R_2	-	+	+	-	+	-	+	-	-	-	+	+	-
106	R_1r	+	-	-	+	+	-	+	+	-	-	+	-	-
107	r”r	-	+	-	+	+	+	+	-	-	-	+	-	+
108	r”r	-	+	+	+	+	+	+	+	-	+	+	+	-
109	R_1r”	-	+	+	+	+	+	-	+	-	-	+	+	-
110	R_zR_2	+	-	-	+	+	-	+	-	+	-	+	+	-

Record the answers in your examination script.

PATIENT	Possible	DONOR UNITS SELECTED
2.1 PATIENT P		
2.2 PATIENT Q		
2.3 PATIENT R		
2.4 PATIENT S		
2.5 PATIENT T		

[10]

QUESTION 3

Interpret the **ABO and Rh (D)** (e.g. A_2 +/POS) blood groups for the following results. Include subgroups and any abnormalities (such as unusual antibodies) in your answers, if present.

Record the answers in your examination script.

	PATIENTS' CELLS AGAINST				PATIENTS' SERUM AGAINST					RH (D) GROUPING
	ANTI-A_1	ANTI-A	ANTI-B	ANTI-A,B	A_1 CELLS	A_2 CELLS	B CELLS	O CELLS	AUTO	IgG
A	0	4	0	4	0	0	4	0	0	0
B	4	4	4	4	0	0	0	0	0	4
C	4	4	0	4	0	0	4	0	0	0
D	0	0	0	0	H	H	H	0	0	4
E	0	0	0	0	0	0	0	0	0	0
F	0	0	4	4	4	4	0	0	0	0
G	0	0	0	0	4	4	4	4	0	4
H	0	4	4	4	4	0	0	0	0	4
I	0	4	0	4	0	0	4	0	0	4
J	0	0	0	0	4	4	4	0	0	4

3.1 PATIENT A

3.2 PATIENT B

3.3 PATIENT C

3.4 PATIENT D

3.5 PATIENT E

3.6 PATIENT F

3.7 PATIENT G

3.8 PATIENT H

3.9 PATIENT I

3.10 PATIENT J

[10]

SECTION C SUBTOTAL: 26

TOTAL MARKS: 180