Red Cell Membrane and Blood Group Antigens
(without reference to ABO and Rh)

Martin Redman

Reference Service Manager - Red Cell Immunohaematology

NHSBT Colindale

Application of other blood group systems

- Literally any variation or polymorphism detected in blood
- usually restricted to blood cell surface antigens - red cell antigens
- synth by the rbc - except Le and Ch/Rg
- biochemical analysis shows two main types of antigen
  - proteins, 1ry prod of bg genes
  - COOH determinates, gene prod are glycosyltransferase enz
- some ag are defined by aa sequence but req COOH for recognition serologically

Blood Group Systems

- One or more ags governed by a single gene locus or a complex of two or more closely linked homologous genes with no recombination occurring between them

- each system is genetically discrete

  - demonstrate genes segregate at meiosis by

    1) analysis of families

    2) gene loci are on different chromosomes or diff part of same chromosome

ISBT Classification

- 33 systems (LAN JR FORS 2012)

  1 or more Ag at 1 locus or 2 or more closely linked homologous genes, no obs recombination between them
  Each system genetically discrete from all others

- 7 collections

  serologically / biochemically / genetically related Ag that do not meet criteria for system status eg. Cs^a/Cs^b, i, Er, Vel

- 2 series

  700 and 901 series contain lo and hi freq Ag that cannot be included in a system or collection

  700 (10) Bx^a Pt^a Re^a

  901 (6) At^a Emm AnWj Sd^a

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 1
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG								
1	**O**	**R1WR1**	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		**0**			**0**								
2	**O**	**R1R1**	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		**0**			**0**								
3	**O**	**R2R2**	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		**3+**			**0**								
4	**O**	**r' r**	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		**0**			**0**								
5	**O**	**r" r**	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		**3+**			**0**								
6	**O**	**r r**	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		**0**			**0**								
7	**O**	**r r**	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	**0**			**0**								
8	**O**	**r r**	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		**0**			**0**								
9	**O**	**r r**	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		**0**			**0**								
10	**O**	**r r**	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		**0**			**0**								
I	**O**	**R1R1**	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		**0**			**0**								
II	**O**	**R2R2**	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		**3+**			**0**								
Auto																					**0**			**0**								

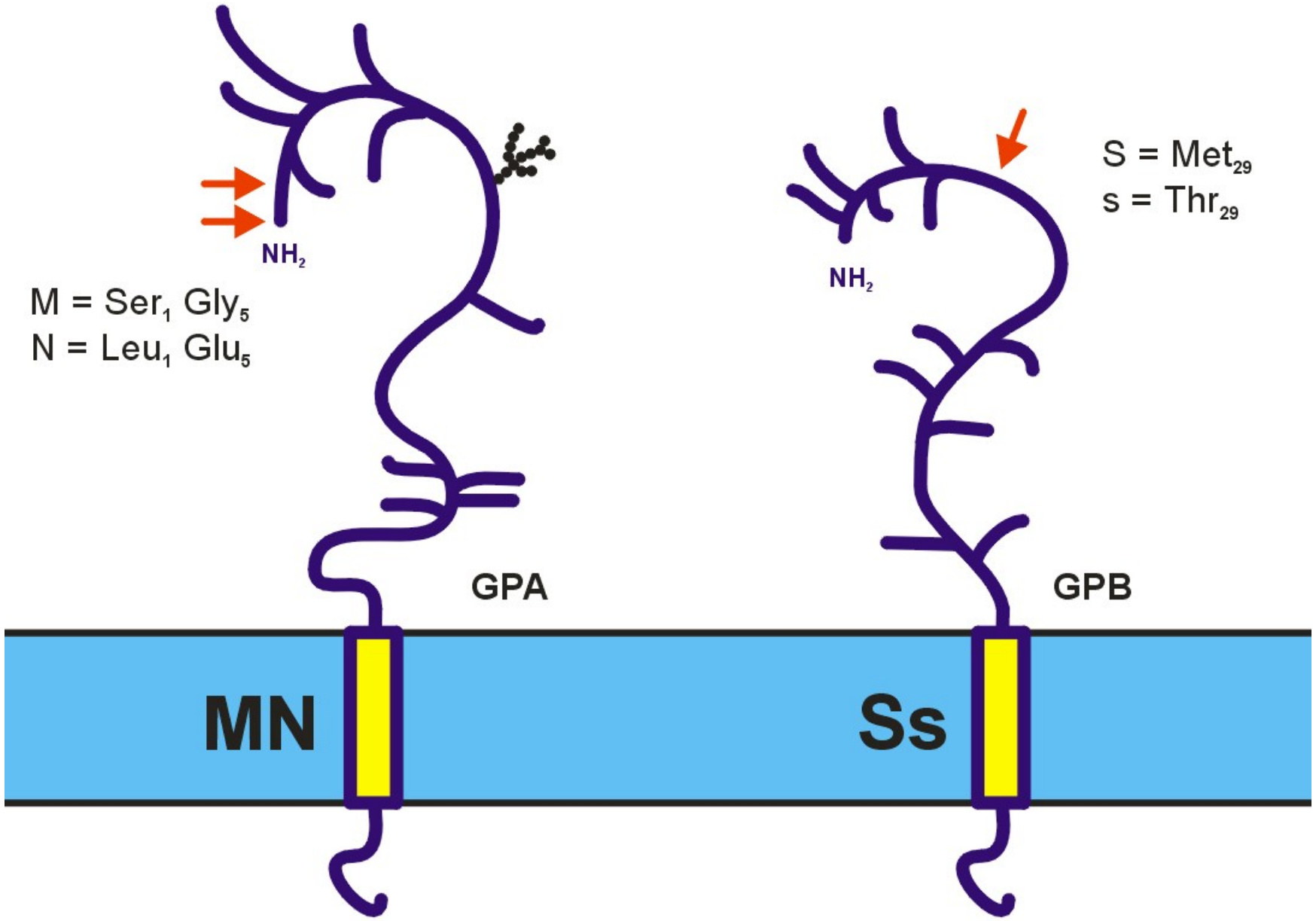
NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 2
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG								
1	**O**	**R1WR1**	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		**0**			**0**								
2	**O**	**R1R1**	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		**0**			**0**								
3	**O**	**R2R2**	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		**4+**			**4+**								
4	**O**	**r' r**	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		**4+**			**4+**								
5	**O**	**r'' r**	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		**4+**			**4+**								
6	**O**	**r r**	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		**4+**			**4+**								
7	**O**	**r r**	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	**4+**			**4+**								
8	**O**	**r r**	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		**4+**			**4+**								
9	**O**	**r r**	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		**4+**			**4+**								
10	**O**	**r r**	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		**4+**			**4+**								
I	**O**	**R1R1**	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		**4+**			**4+**								
II	**O**	**R2R2**	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		**4+**			**4+**								
Auto																					**0**			**0**								

MNS System ISBT No.002 Chr4

- 2nd system discovered
- 46 antigens
- 1927 Landsteiner and Levine found -M and -N in rabbits immunised with human rbc
- M and N ags 1 x 10^6 sites/cell (MM / NN)
- 1947 Walsh and Montgomery found -S
- 1951 Levine described -s
- SS 250 000 sites / cell ss 170 000 sites /cell
- MN found on Glycophorin A (GPA)
- Ss found on Glycophorin B (GPB)
- Ag destroyed / modified by proteolytic enzymes
  present on cord cells
- Ab do not bind Complement, often show doseage
- Null phenotypes
  - En(a-) lack GPA (M,N)
  - U- lack GPB (S,s,U)
  - M^k M^k lack GPA and GPB


NH2
M = Ser1 Gly5
N = Leu1 Glu5
NH2
S = Met29
s = Thr29
GPA
GPB
MN
Ss

MNS system antibodies

Ab	IgM	IgG	sal	enz	IAT	HTR	HDN	pheno	%	notes
-M	Y	some	Y	N	some	Y	N	NN	22	
-N	Y	N	Y	N	N	N	N	MM	28	
-S	some	Y	some	N	Y	Y	Y	ss	45	
-s	N	Y	N	Y	Y	Y	Y	SS	11	
-U	N	Y	N	Y	Y	Y	Y	S-s-U-	<1	Black

NBS-London & South East Zone Antibody Identification Panel

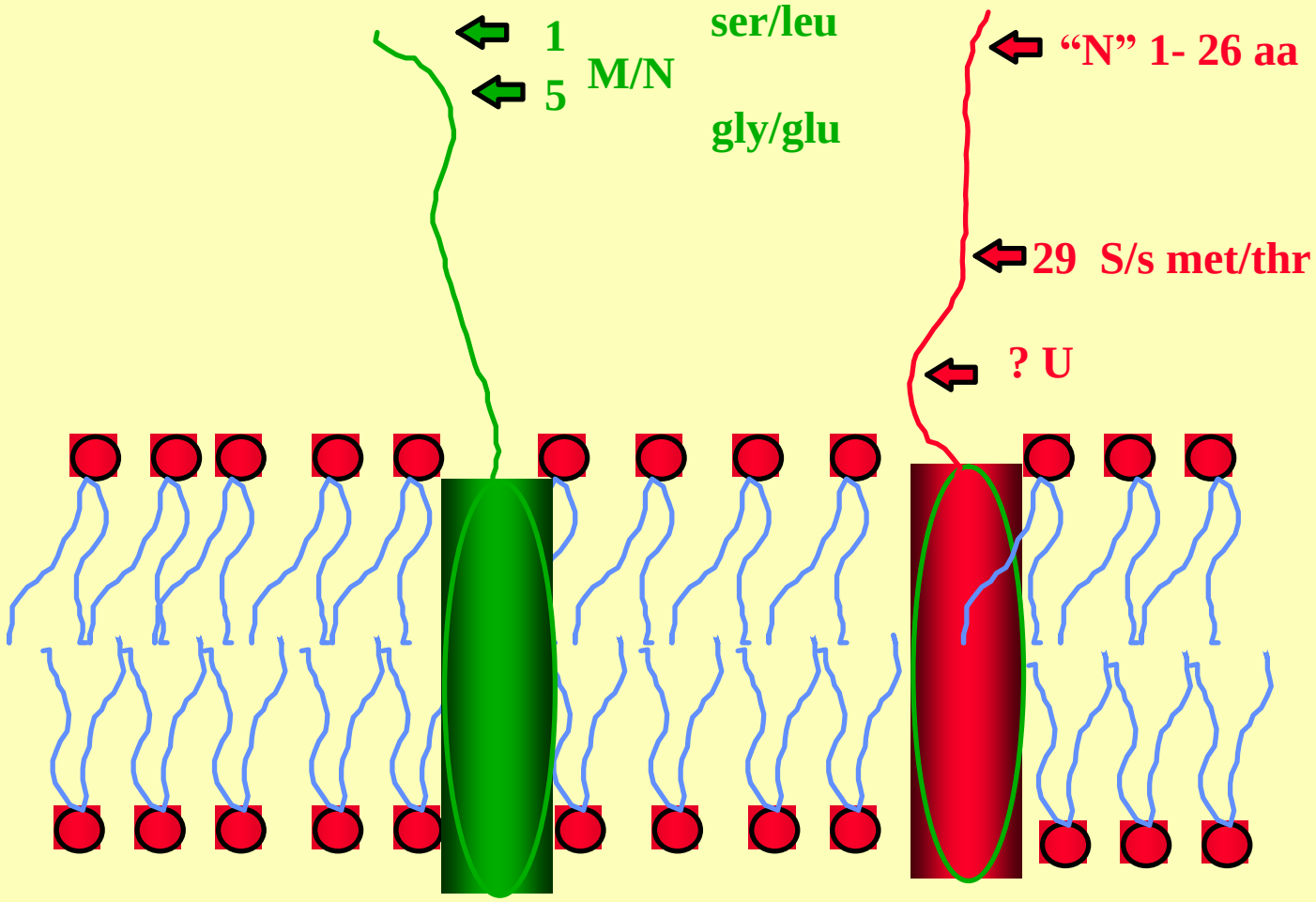
PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 3
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

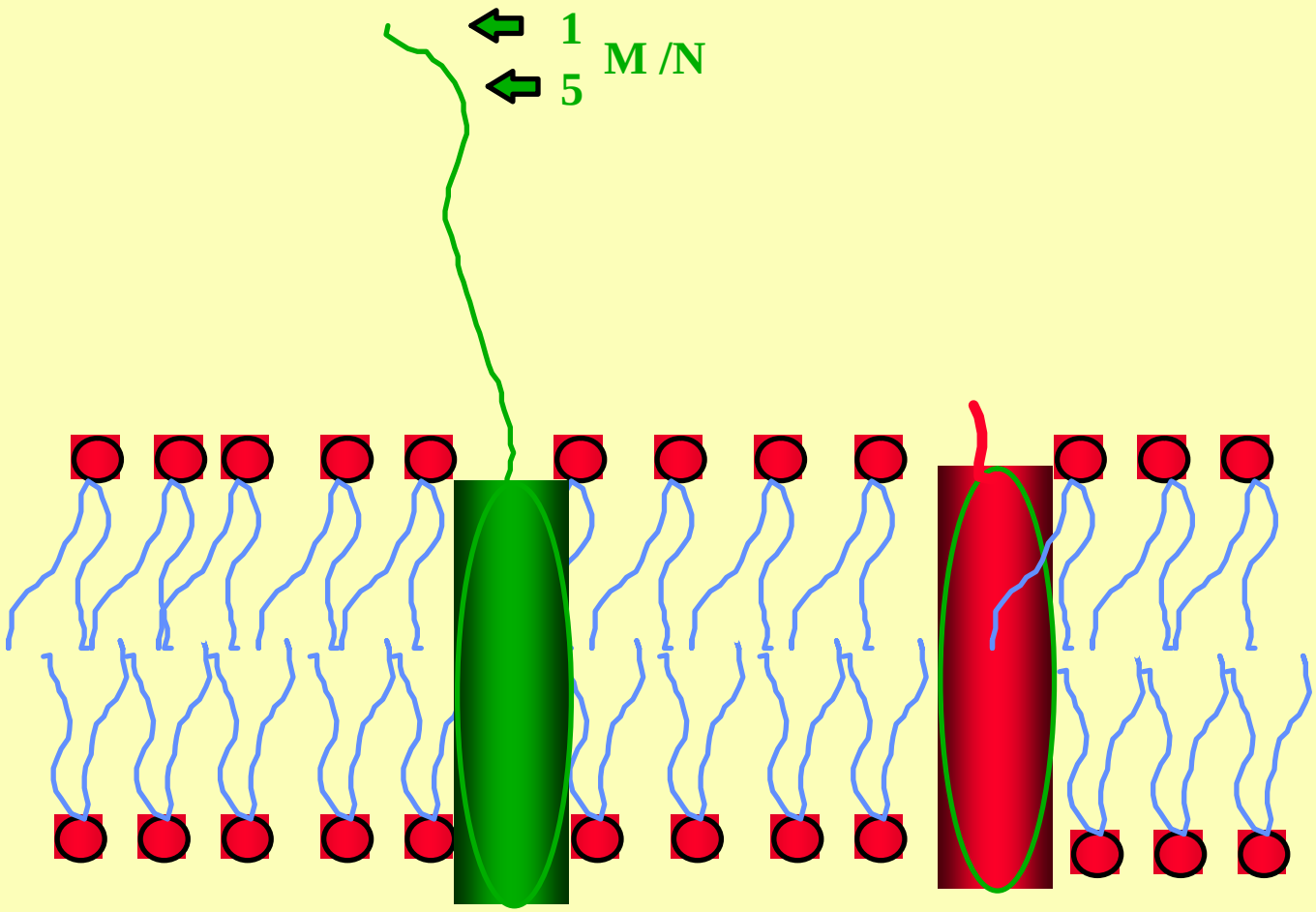
	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG		15o						
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		0			3+		4+						
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		0			1+		4+						
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		0			0		0						
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		0			0		0						
5	O	r'' r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		0			3+		4+						
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		0			3+		4+						
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	0			0		0						
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		0			0		0						
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		0			1+		4+						
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		0			3+		4+						
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		0			3+		4+						
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		0			1+		4+						
Auto																					0			0		0						

NBS-London & South East Zone Antibody Identification Panel

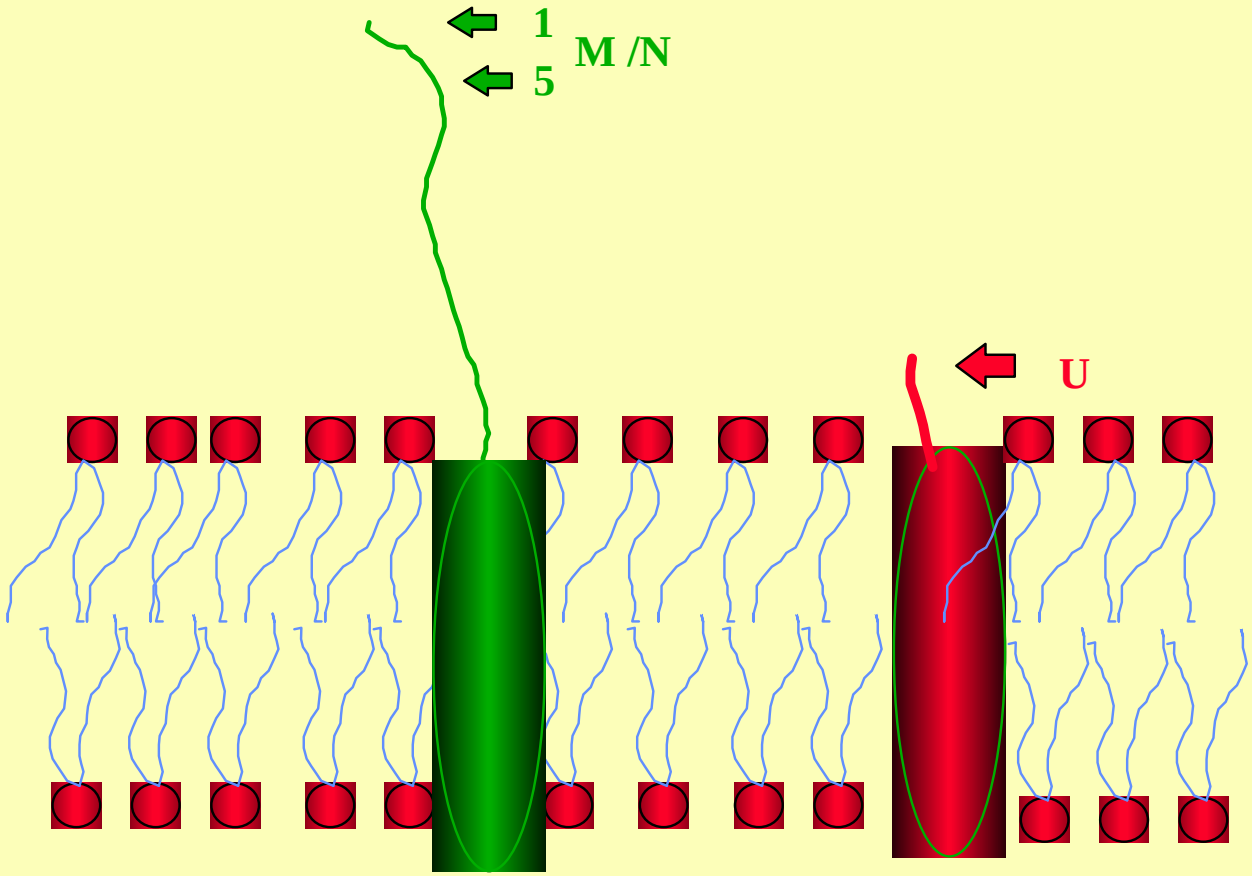
PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 5
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		0			2+
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		0			0
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		0			0
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		0			0
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		0			3+
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		0			3+
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	0			0
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		0			0
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		0			0
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		0			0
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		0			3+
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		0			0
Auto																					0			0


1
5
M/N
ser/leu
gly/glu
"N" 1- 26 aa
29 S/s met/thr
? U
GLYCOPHORIN A
GLYCOPHORIN B



GLYCOPHORIN A GLYCOPHORIN B



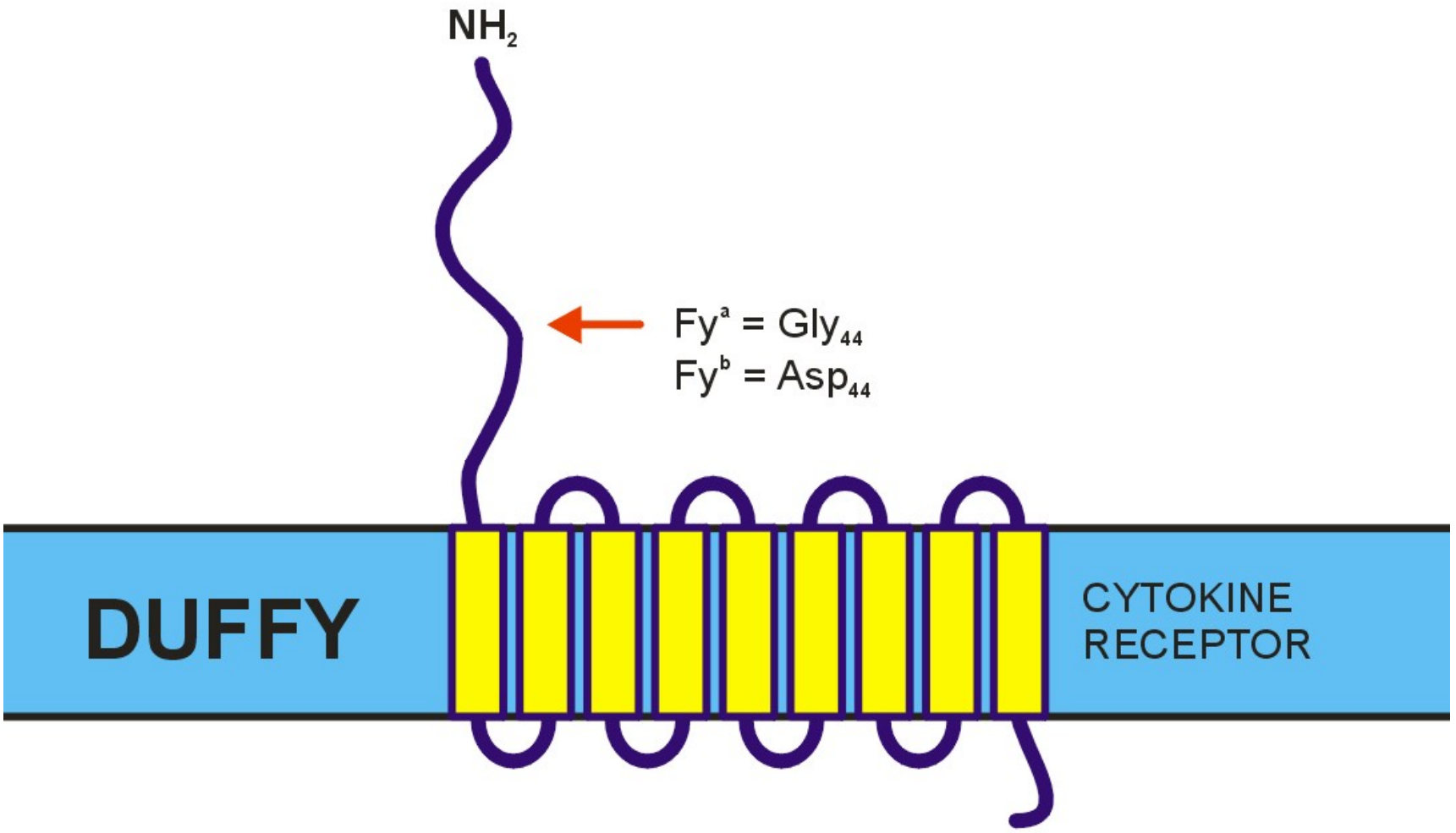
GLYCOPHORIN A GLYCOPHORIN B

Duffy System ISBT No. 008 Chr1

- 1950 Cutbush Fy^a (FY1)
- 1951 Ilkin Fy^b (FY2)
- 13 - 14 000 sites / cell
- 3 phenotypes in Whites Fy(a+b-) 20%
  Fy(a-b+) 33%
  Fy(a+b+) 47%

  in Blacks Fy(a-b-) 68%
  silent *Fy* gene - rbc resistant to P.vivax infection
  IL-8

- Fy antigens are destoyed / modified by protease enzymes
- Fy3 absent from Fy(a-b-) cells, resistant to protease treatment
- Fy5 resembles Fy3, absent from Fy:3 Rh_{null} cells
- Fy^x weak Fy^b


NH2
Fya = Gly44
Fyb = Asp44
DUFFY
CYTOKINE
RECEPTOR

Fy System Antibodies

Ab	IgM	IgG	sal	enz	IAT	HTR	HDN	pheno	%	notes
-Fy^a		Y		N	Y	Y	Y	Fy(a-b+)	33	
-Fy^b		Y		N	Y	Y	Y	Fy(a+b-)	20	
-Fy3		Y		Y	Y	Y	rare	Fy(a-b-)	0	White
									68	Black

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 4
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	**O**	**R1WR1**	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		**0**			**3+**
2	**O**	**R1R1**	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		**0**			**0**
3	**O**	**R2R2**	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		**0**			**0**
4	**O**	**r' r**	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		**0**			**0**
5	**O**	**r" r**	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		**0**			**3+**
6	**O**	**r r**	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		**0**			**0**
7	**O**	**r r**	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	**0**			**3+**
8	**O**	**r r**	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		**0**			**2+**
9	**O**	**r r**	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		**0**			**0**
10	**O**	**r r**	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		**0**			**3+**
I	**O**	**R1R1**	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		**0**			**0**
II	**O**	**R2R2**	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		**0**			**3+**
Auto																					**0**			**0**

Lewis System ISBT No.007

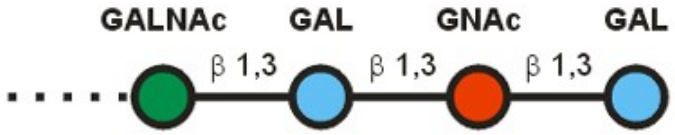
- **Adults with *Le* gene are Le(a+b-) or Le(a-b+)**

  secretors of ABH are Le(a-b+)
  non-sec of ABH are Le(a+b-)

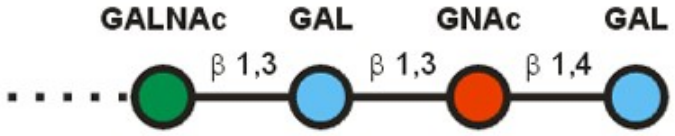
  homozygous for *le* are Le(a-b-)

- **Ags are glycolipids that exchange with lipids in rbc membrane**
- **pregnant women can become Le(a-b-) , Le abs common**
- **neonates are Le(a-b-), infants may become Le(a+b+)**
- **Le(a+b+) common in E/SE Asia and Pacific ? Weak Se**
- **Le^a substance in saliva of Le(a+b-) and Le(a-b+)**
- **Le^b substance in Le(a-b+)**

Precursor Substances



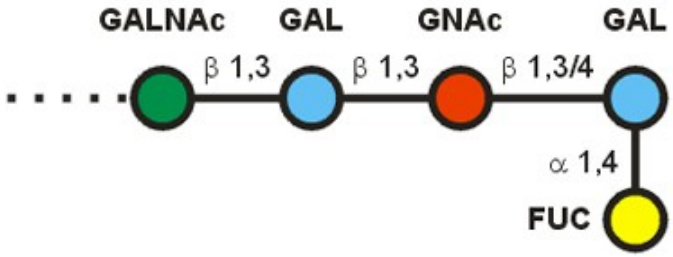
Type 1 Chains (β1,3)
H, A and B antigens acquired from plasma are glycosphingolipids



Type 2 Chains (β1,4)
H, A and B antigens synthesised by red cell precursors attached to glycosphingolipids and glycoproteins

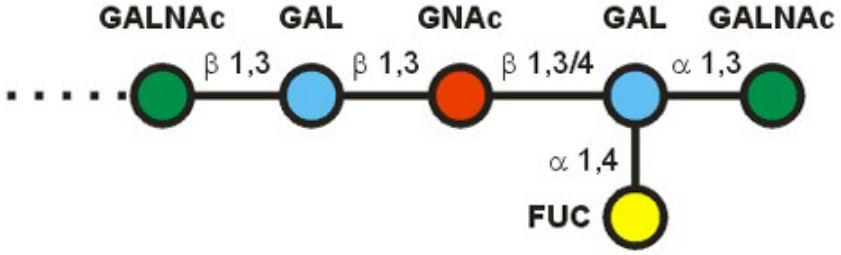
GALNAc	N-acetyl-D-galactosamine
GAL	D-galactose
GNAc	N-acetyl-D-glucosamine
FUC	L-fucose

H Substance

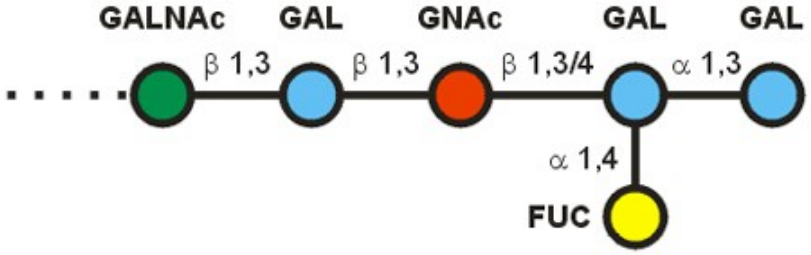


Type 1 chain - when *H* and *Se* are active in sec. cells (plasma)
Type 2 chain - when *H* is active (synth by red cell precursors)

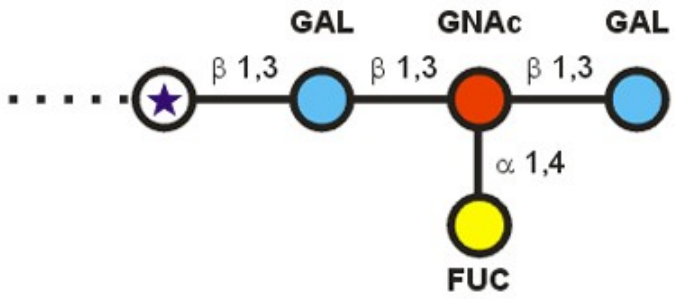
A Substance



B Substance

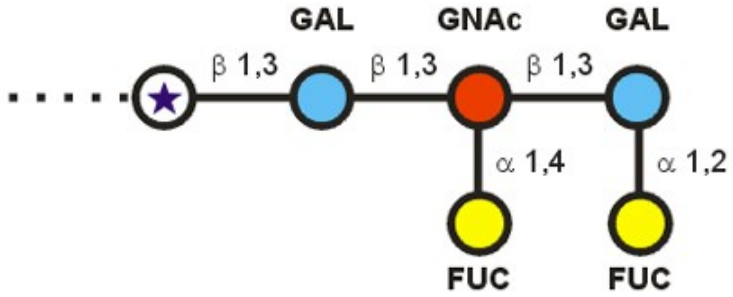


Le[a] Structure



Genotype *sese / Le* (or *hh,Le*)

Le[b] Structure



Genotype *H,Se,Le*

★ Glucose if bound to glycosphingolipid (plasma)
Galactosamine if bound to glycoprotein (saliva)

Lewis System Antibodies

Ab	IgM	IgG	sal	enz	IAT	HTR	HDN	pheno	%	notes
-Le^{a}	Y		Y	Y	Y	rare	N	Le(a-)	78	xm@37
-Le^{b}	Y		Y	Y	Y	N	N	Le(b-)	28	xm@37
-Le^{a+b}	Y		Y	Y	Y	rare	N	Le(a-b-)	6	xm@37
-Le^{bH}	Y		Y	Y	Y	N	N	A1 / B		

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 6
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		0			0
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		2+			3+
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		0			0
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		0			0
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		0			0
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		2+			3+
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	0			0
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		0			0
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		2+			3+
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		0			0
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		0			0
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		2+			3+
Auto																					0			0

NBS-London & South East Zone Antibody Identification Panel

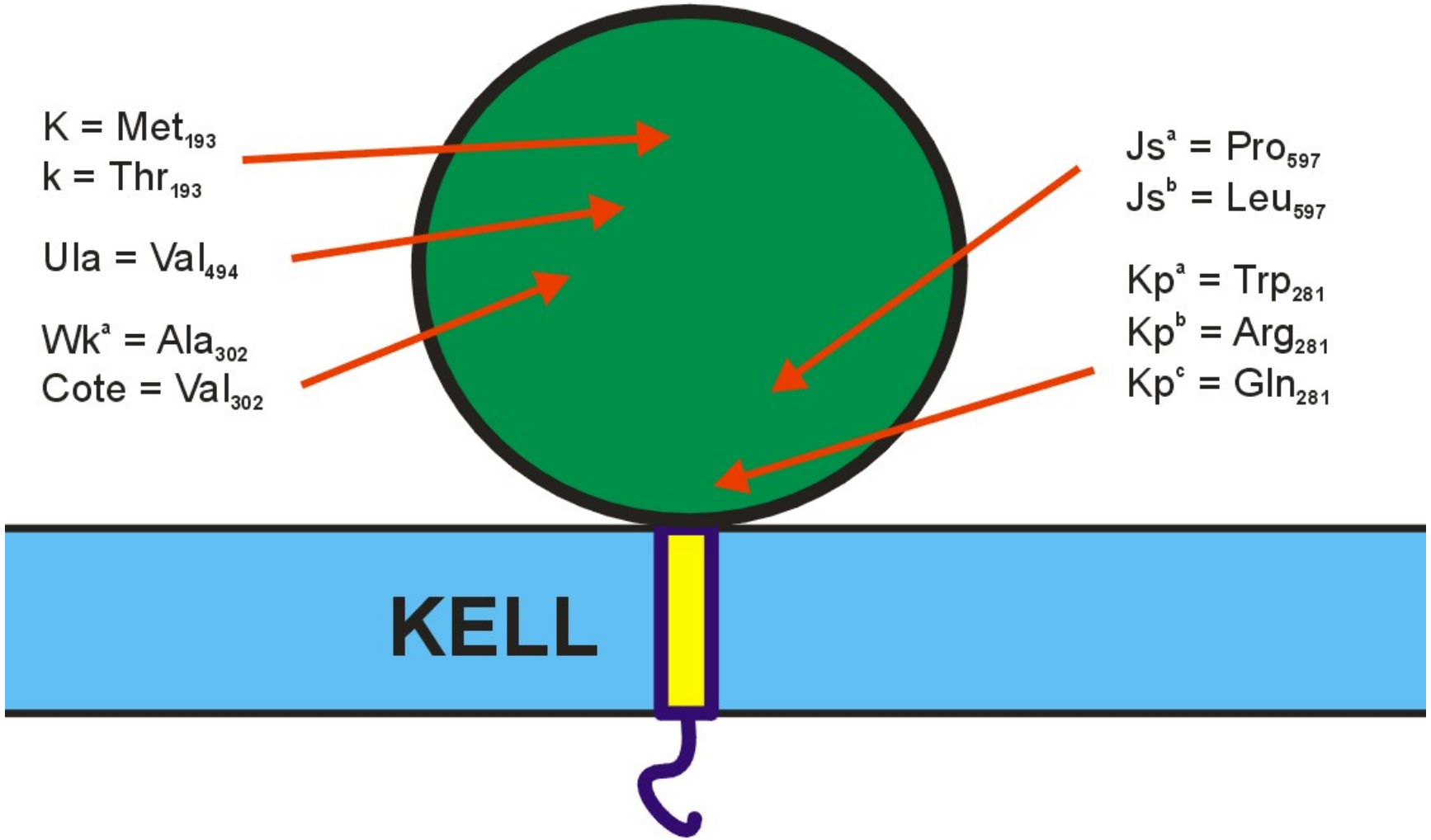
PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 9
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	**O**	**R1WR1**	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		**2+**			**2+**
2	**O**	**R1R1**	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		**2+**			**2+**
3	**O**	**R2R2**	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		**2+**			**2+**
4	**O**	**r' r**	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		**0**			**0**
5	**O**	**r" r**	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		**0**			**0**
6	**O**	**r r**	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		**2+**			**2+**
7	**O**	**r r**	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	**2+**			**2+**
8	**O**	**r r**	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		**0**			**0**
9	**O**	**r r**	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		**2+**			**2+**
10	**O**	**r r**	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		**2+**			**2+**
I	**O**	**R1R1**	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		**2+**			**2+**
II	**O**	**R2R2**	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		**2+**			**2+**
Auto																					**0**			**0**

KELL System ISBT No.006 Chr7

- 1946 Coombs, Mourant and Race described Kell
- 1st system disclosed by IAT test
- K1 – K35 (3 obsolete)
- 2 500 - 6 200 sites / cell
- 4 sets of antithetical antigens K (K1) k (K2)
  Kp^a(K3) Kp^b(K4) Kp^c(K21)
  Js^a(K6) Js^b(K7)
  K11 Wk^a(K17)

- K_o null phenotype - no Kell antigens (amorphic gene)
- McLeod phenotype - assoc x-linked CGD, muscular/neuro defects
  - weak high freq K antigens
  - make anti- KL reacts with all except McLeod
  - mixture of -Kx reacts with K_o cells
    -Km (K20) neg v K_o cells


K = Met193
k = Thr193
Ula = Val494
Wka = Ala302
Cote = Val302
Jsa = Pro597
Jsb = Leu597
Kpa = Trp281
Kpb = Arg281
Kpc = Gln281
KELL

Kell System Antibodies

Ab	IgM	IgG	sal	enz	IAT	HTR	HDN	pheno	%	notes
-K	rare	Y	rare	some	Y	Y	Y	kk	91	
-k		Y		some	Y	Y	Y	KK	0.2	
-Kp^a		Y		some	Y	Y	Y	Kp(a-)	98	
-Kp^b		Y		some	Y	Y	Y	Kp(b-)	<0.1	
-Js^a		Y		some	Y	Y	Y	Js(a-)	>99	White
-Js^b		Y		some	Y	Y	Y	Js(b-)	<0.1	Black

NBS-London & South East Zone Antibody Identification Panel

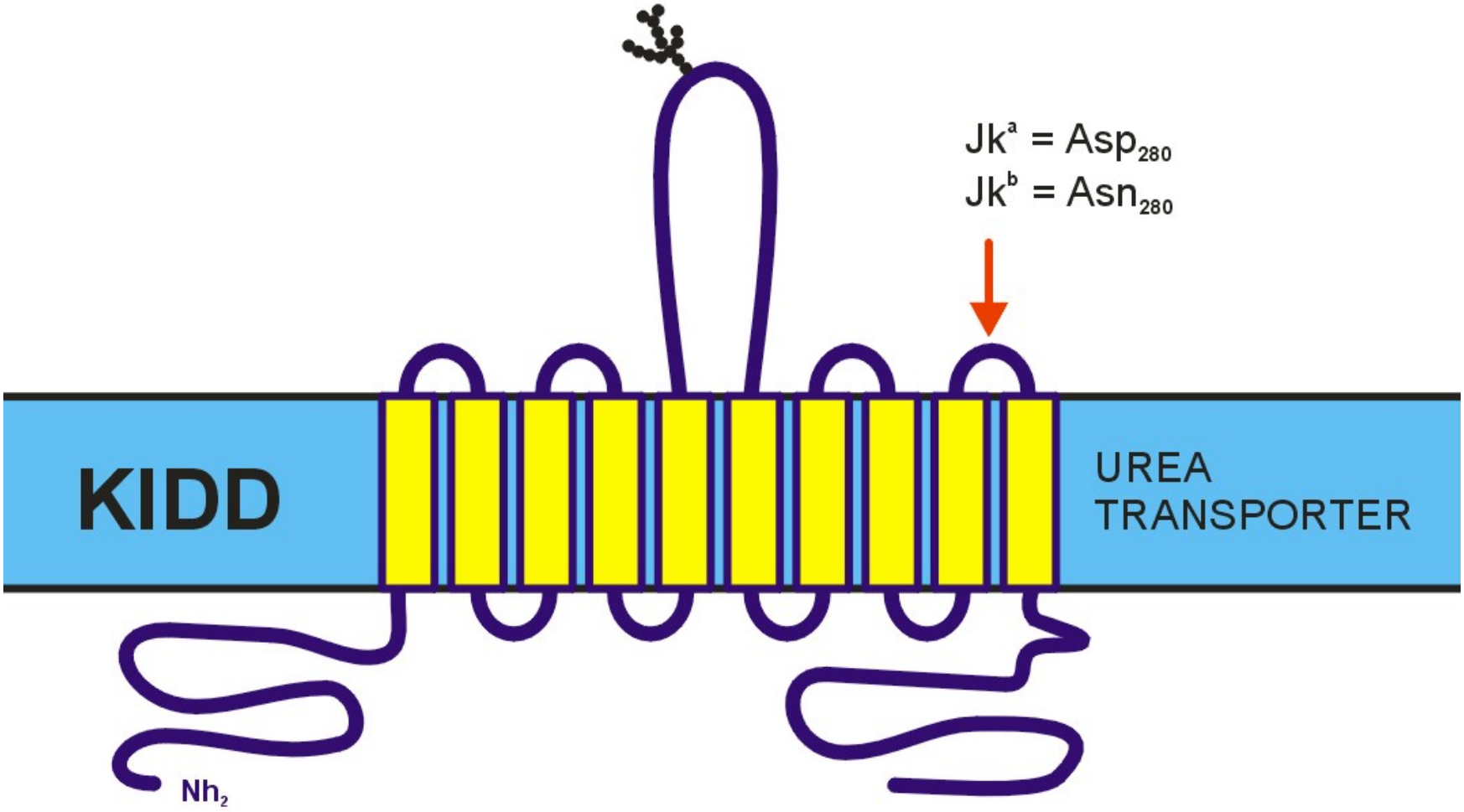
PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 7
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		0			0
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		3+			3+
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		0			0
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		0			0
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		0			0
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		0			0
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	3+			3+
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		0			0
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		0			0
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		3+			3+
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		3+			3+
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		0			0
Auto																					0			0

KIDD System ISBT No.009 Chr18

- 1951 Allen Jk^a (JK1)
- 1953 Plaut Jk^b (JK2)
- 1959 Pinkerton Jk^{a+b} (JK3) absent on Jk(a-b-)
- 10 000 sites / cell

- Antibody can be difficult to detect
- Cause severe or even fatal HTRs - often delayed
- Enzyme techniques used to enhance detection
- 2-stage IAT also used (EDTA serum then add fresh serum C')
- Jk(a-b-) rbc resistant to urea lysis
- auto-Jk^a and -Jk^b described in AIHA and drug induced AIHA


Jk^{a} = Asp$_{280}$
Jk^{b} = Asn$_{280}$
KIDD
UREA
TRANSPORTER
Nh$_{2}$

Kidd System Antibodies

Ab	IgM	IgG	sal	enz	IAT	HTR	HDN	pheno	%	notes
-Jk^{a}		Y		Y	Y	Y	some	Jk(a-b+)	25	
-Jk^{b}		Y		Y	Y	Y	rare	Jk(a+b-)	25	
-Jk3	rare	Y		Y	Y	Y	Y	Jk(a-b-)	<0.1	

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 8
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		3+			2+
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		0			0
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		0			0
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		3+			2+
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		3+			2+
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		0			0
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	0			0
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		3+			2+
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		0			0
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		2+			2+
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		0			0
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		3+			2+
Auto																					0			0

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 10
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		4+			4+
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		4+			4+
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		4+			4+
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		4+			4+
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		4+			4+
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		4+			4+
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	4+			4+
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		4+			4+
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		4+			4+
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		4+			4+
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		4+			4+
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		4+			4+
Auto																					0			0

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS	PANEL 11
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:		

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	**O**	**R1WR1**	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		**4+**			**4+**
2	**O**	**R1R1**	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		**4+**			**4+**
3	**O**	**R2R2**	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		**4+**			**4+**
4	**O**	**r' r**	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		**4+**			**4+**
5	**O**	**r" r**	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		**4+**			**4+**
6	**O**	**r r**	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		**4+**			**4+**
7	**O**	**r r**	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	**4+**			**4+**
8	**O**	**r r**	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		**4+**			**4+**
9	**O**	**r r**	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		**4+**			**4+**
10	**O**	**r r**	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		**4+**			**4+**
I	**O**	**R1R1**	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		**4+**			**4+**
II	**O**	**R2R2**	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		**4+**			**4+**
Auto																					**4+**			**4+**

I (ISBT 027) i (Collection ISBT 207)

- **1956 Wiener et al described a pan-agg in CHAD**
- **5 in 22 000 adult rbc were non-reactive**
- **Antibody called anti-I which described an antigen I**
- **1960 Marsh and Jenkins described 1st example of anti-i**

- **Cord blood I- i+)**
) mostly
- **Adult rbc I+ i-)**

- **On same glycoprotein & glycolipid chains that carry H, A and B ag**
- **On same glycolipids that carry H, A, B, Le^a and Le^b in secretions**
- **Closer to the membrane than terminal COOH of H, A and B**

Antibodies

- **Anti-I / i** — **fix Complement**

- **Anti-I** — **found in 100% adults**
- **Auto anti-I** — **found in patients with CHAD**

  autoabsorb serum
  test at strict 37C
  may need to supply ii (I-) blood

- **Anti-i** — **IgM not reacting at 37C**
  reacts with cord but not adult rbc
  infectious mononucleosis ---> haem anaemia
  ? caused by IgG RT component + IgM anti-IgG
  active at 37C

e Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 12
NING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG		15O						
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		4+			0		4+						
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		4+			0		4+						
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		4+			0		4+						
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		4+			0		4+						
5	O	r'' r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		4+			0		4+						
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		4+			0		4+						
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	4+			0		4+						
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		4+			0		4+						
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		4+			0		4+						
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		4+			0		4+						
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		4+			0		4+						
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		4+			0		4+						
Auto																					4+			0		4+						
O cord																					0			0		0						
O ii adult																					0			0		0						

P System (P1PK) ISBT No.003 Chr22

- 1927 Landsteiner and Weiner - immunising rabbits with human rbc
- 1959 Matson described P^k moved from Collections to P System 2012
- 1962 Morgan and Watkins - isolated a P1 active glycoprotein from hydatid cyst fluid (trisaccharide)

- P1 substance used to inhibit the antibody

- P, LKE different Chr and biochemical pathway

- Globoside collection (ISBT 209) P is GLOBO1 ISBT 028

  Tippet 1965 LKE is GLOBO3 ISBT 209

  Levine 1951 p 1:160 000

P System antibodies

Ab	IgM	IgG	sal	enz	IAT	HTR	HDN	pheno	%	notes
-P1	Y	some	Y	Y	some	rare	N	P2	21	
-P	Y	some	Y	some	some	Y	N	P^k	<1	PCH/D-L
-P1PP^k	Y	some	Y	Y	Y	Y	Y	pp	<0.1	
-LKE	Y	N	Y	Y	N	N	N	LKE-	2	

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 13
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		0			0
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		2+			1+
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		4+			2+
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		4+			2+
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		4+			2+
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		4+			2+
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	4+			2+
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		4+			2+
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		4+			2+
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		4+			2+
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		4+			2+
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		4+			2+
Auto																					0			0

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 14
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		2+			2+
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		4+			4+
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		0			0
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		2+			2+
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		2+			2+
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		0			0
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	4+			4+
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		2+			2+
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		0			0
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		4+			4+
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		4+			4+
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		2+			2+
Auto																					0			0

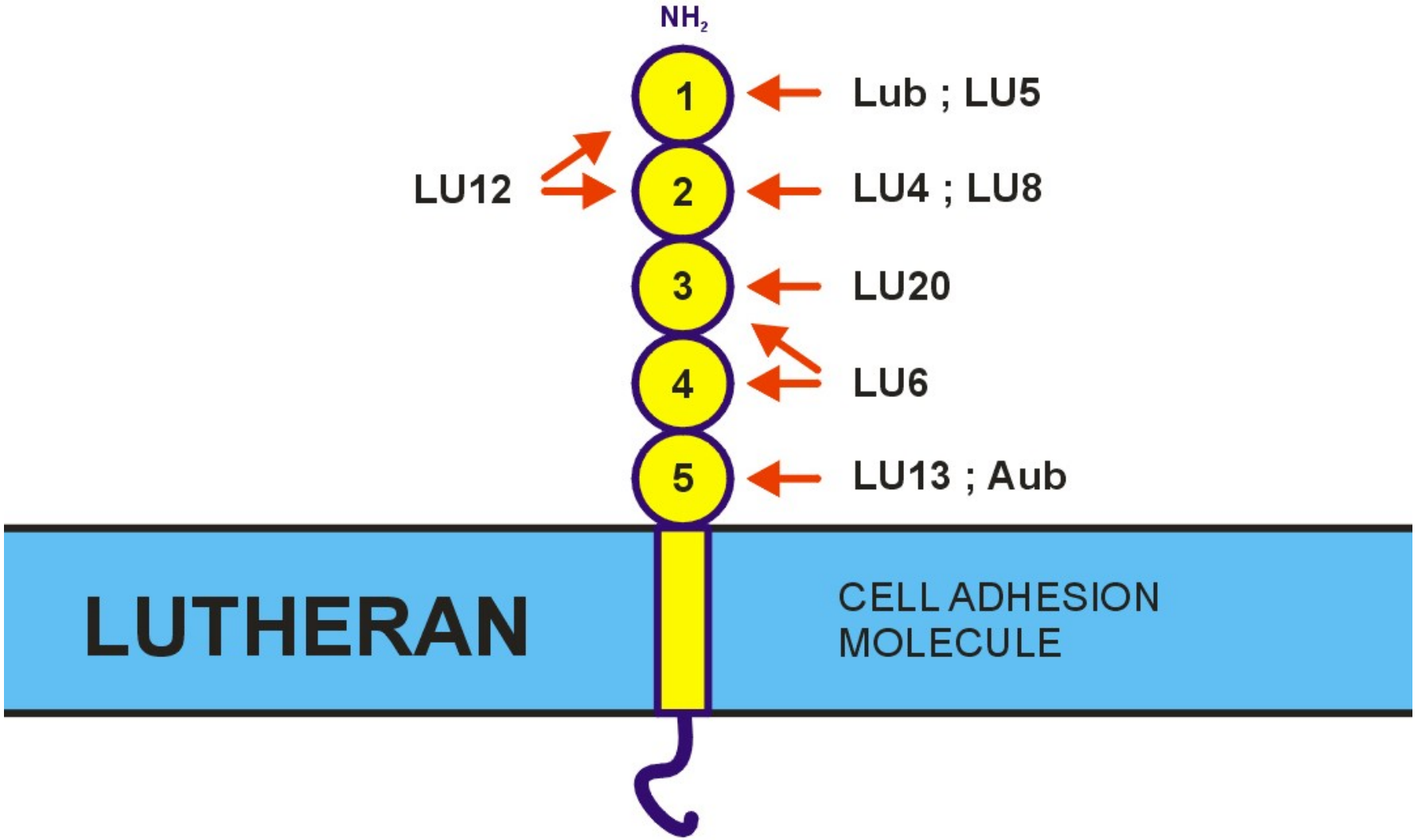
Lutheran System ISBT No.005 Chr19

- **1945 Callender Lu^a (LU1)**
- **1956 Cutbush Lu^b (LU2)**
- **20 antigens in the system LU 1-22 (2 obsolete)**
- **1 000 - 4 000 sites / cell**

- **Lu(a-b-) lack all Lutheran antigens**

  - **homozygous autosomal recessive amorph gene**
  - **heterozygous dominant suppressor gene [*In(Lu)*]**
  - **hemizygous recessive X-linked suppressor gene**

  - **only the first is the true null phenotype**


NH2
1
2
3
4
5
Lub ; LU5
LU12
LU4 ; LU8
LU20
LU6
LU13 ; Aub
LUTHERAN
CELL ADHESION
MOLECULE

Lutheran System Antibodies

Ab	IgM	IgG	sal	enz	IAT	HTR	HDN	pheno	%	notes
-Lu^a	most	some	Y	some	some	some*	?**	Lu(a-)	92	
-Lu^b	some	most	some	some	Y	some*	?**	Lu(b-)	<1	
-Lu3	some	most	some		Y	some*	?**	Lu(a-b-)	<1	

* mild delayed reaction

** poorly developed on neonatal rbc

e Antibody Identification Panel

ANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 15
NING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG			150						
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		4+			4+			4+						
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		4+			4+			4+						
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		4+			4+			4+						
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		4+			4+			4+						
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		4+			4+			4+						
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		4+			4+			4+						
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	4+			4+			4+						
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		4+			4+			4+						
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		4+			4+			4+						
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		4+			4+			4+						
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		4+			4+			4+						
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		4+			4+			4+						
Auto																					0			0			0						
A1																					0			0			0						
A1																					0			0			0						
A2																					2+			2+			4+						
A2																					2+			2+			4+						

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 16
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG
1	O	R1WR1	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		0			1+
2	O	R1R1	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		0			2+
3	O	R2R2	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		0			1+
4	O	r' r	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		0			1+
5	O	r" r	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		0			2+
6	O	r r	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		0			2+
7	O	r r	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	0			1+
8	O	r r	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		0			1+
9	O	r r	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		0			1+
10	O	r r	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		0			1+
I	O	R1R1	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		0			1+
II	O	R2R2	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		0			1+
Auto																					0			0

Dil	4	8	16	32	64	128	256	512	1K	2K
Sal	2+	2+	2+	2+	1+	1+	1+	1+	1+	1+
AB serum	0	0	0	0	0	0	0	0	0	0

Complement Associated Antigens

- Proteins naturally adsorbed from plasma
- C4 fragments of complement
- C4 from plasma neutralises the antibody activity
- Ch^a (Chido) Rg^a (Rodgers)
- No clinical significance

NBS-London & South East Zone Antibody Identification Panel

PANEL: 1121	Expiry: 220900	NAME:	SAMPLE No: LS PANEL 16
SCREENING CELLS: 2C2019	Expiry: 290900	HOSPITAL:	

	Gp	Rh	M	N	S	s	P1	Lua	Lub	K	k	Kpa	Kpb	Lea	Leb	Fya	Fyb	Jka	Jkb	Others	Dia Pap	Tube Pap	Dia AG	Tube AG								
1	**O**	**R1WR1**	+	0	+	+	2+	+	+	0	+	0	+	0	+	+	0	+	0		**2+**			**1+**								
2	**O**	**R1R1**	+	+	0	+	0	0	+	+	+	0	+	+	0	0	+	0	+		**2+**			**2+**								
3	**O**	**R2R2**	0	+	0	+	2+	0	+	0	+	0	+	0	+	0	+	0	+		**2+**			**1+**								
4	**O**	**r' r**	0	+	0	+	0	0	+	0	+	0	+	0	0	0	+	+	0		**2+**			**1+**								
5	**O**	**r" r**	+	0	+	0	4+	0	+	0	+	0	+	0	0	+	0	+	0		**2+**			**2+**								
6	**O**	**r r**	+	0	+	0	0	0	+	0	+	0	+	+	0	0	+	0	+		**2+**			**2+**								
7	**O**	**r r**	0	+	0	+	0	0	+	+	+	0	+	0	+	+	0	0	+	Ch neg	**2+**			**1+**								
8	**O**	**r r**	0	+	0	+	0	+	+	0	+	0	+	0	0	+	+	+	0		**2+**			**1+**								
9	**O**	**r r**	+	+	0	+	4+	0	+	0	+	+	+	+	0	0	+	0	+		**2+**			**1+**								
10	**O**	**r r**	+	0	0	+	3+	+	+	+	0	0	+	0	+	+	0	+	+		**2+**			**1+**								
I	**O**	**R1R1**	+	0	+	0	4+	0	+	+	+	0	+	0	+	0	+	0	+		**2+**			**1+**								
II	**O**	**R2R2**	+	+	0	+	4+	0	+	0	+	0	+	+	0	+	0	+	0		**2+**			**1+**								
Auto																					**0**			**0**								

Dil	4	8	16	32	64	128	256	512	1K	2K
Sal	2+	2+	2+	2+	1+	1+	1+	1+	1+	1+
AB serum	2+	2+	2+	2+	1+	1+	1+	1+	1+	1+

CR 1 Associated Antigens

- CR 1 found mainly on white cells
- Expression on red cells variable
- Kn^a (Knops), Cs^a, McCoy etc.
- No clinical significance