

1SPCJOH 1PUFOU \*OUFSGBDJBM 3FTJEVFT JO .  
XJUI (MZDPQSPUFJOT 7JTVBM 0[ JQW JDPJ ) \*7 "

3DUDPDVLYDQ 0DQLYDQQDQ DQG \*DQJDWKDUDQ 0XUDOLWKDUDQ

'HSDUWPHQW RI 0LFURELRORJ\ %KDUDWKLGVDVQ 8QLYHUVLW\ 7LUXFKLUDSSDOOL ,QGLD

&RUUHVSRRGLQ\*~~DDXDKR~~DUDQ 0XUDOLWKDUDQ 'HSDUWPHQW RI 0LFURELRORJ\ %KDUDWKLGVDVQ 8QLYHU  
PDLO GUJP#EGX DF LQ

5HFHLYHG00~~DFW~~ \$FFHSWHG GDWH3 X2~~FOV~~R\BKHUQ ~~FOV~~RVEHHU

&RS\ULJKW ( 0DQLYDQQDQ 3 HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHU W  
XQUHVWULFWHG XVH GLVWULEXWLRQ DQG UHSURGXFWLRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO D

\$EVWUDFW

0LFURY~~YL~~UL~~LDQ~~QQRVH ELQGLQJ DQWL +,9 +XPDQ ,PPXQRGHILFLHQF\ YLUXV OHFWL  
DJHQW LQ FRPEDWLQJ +,9 /LJDQG ELQGLQJ UHVLGXHV RI 0LFURYLULQ ZDV WDNH  
UHVLGXHV DQG LGHQWLI\ VXUIDFH %XULHG UHVLGXHV EDVHG RQ \$FFHVVLEOH VXUI  
\$IWHU FDWHJRULJDWLRQ &RPSDUDWLYH %IDWRUV ZHUH DVVHVVHG IRU SUHGLF  
/LJDQG ELQGLQJ UHVLGXHV )XUWKHUPRUH GRFNLQJ PLFURYLULQ ZLWK JO\FRSURW  
LQWHUIDFLDO UHVLGXHV LQ FRPSOH[HV DQG DIILUPV WKH FRPSXWDWLRQDO GLVVH

DV EXULHG UHVLGXHV DV HQHUJLHV LQ FDO PRO SURY LGH ELQGLQJ HQHUJLHV  
 0RUHRYHU UHGXFHG ELQGLQJ HQHUJLHV \LHOG KLJK

&RPSDUDWLYH % IDFWRU DQDO\VLV DQG SUHGLFWLRQ RI ULJLG QRQ  
 ULJLG QDWXUH RI OLJDQG ELQGLQJ UHVLGXHV

%LQGLQJ IDFWRU IRU OLJDQG ELQGLQJ UHVLGXHV ZHUH SUHGLFWHG XVLQJ  
 %)3UHG > @ DQG LQGLYLGXDO % IDFWRU ZHUH VWDWLVWLFDOO\ GHSLFWHG IF  
 VXPPDUL]LQJ ULJLG QRQ ULJLG QDWXUH RI WKH OLJDQG ELQGLQJ UHVLGXHV  
 QRUPDOL]HG % IDFWRU SHU UHVLGXH %L 1 ZDV FDOFXODWHG EDVHG RQ

%L 1 %L %L!

ž %L

ZKHUH %L % IDFWRU RI UHVLGXH

%L! PHDQ % IDFWRU

ž 6WDQGDUG GHYLDWLRQ

%L@ ZHUH FRQVLGHURG DVZHUJLGHZHUJLGH  
 QRQ ULJLG > @

\$VS	+IGURJHQ ERQG
.OH	+IGURJHQ ERQG
\$VQ	+IGURJHQ ERQG
*OX	+IGURJHQ ERQG
7KU	+IGURJHQ ERQG
&IV	'LVXOILGH EULGJH
*OX	+IGURJHQ ERQG
\$VS	+IGURJHQ ERQG
&IV	'LVXOILGH EULGJH
&IV	'LVXOILGH EULGJH

5HVXOWV DQG 'LVFXVVLRQ

**7DEOH**

/LJDQG ELQGLQJ UHVLGXHV LQ D SURWHLQ FRQVWLWXWH D VXEVHW RI KRWVSR  
 UHVLGXHV LQ SURWHLQ SURWHLQ LQWHUDFWLRQV +RWVSRW UHVLGXHV KDYH E  
 FRUUHODWHG WR HQHUJ\ KRW VSRWV DQG VWUXFWXUDOO\ FRQVHUYHG UHVLGXHV  
 VSRWV LQ WKH LQWHUIDFH RI SURWHLQ FRPSOH[HV LGHQWLI\ XQLTXH ELQGLQJ  
 VLWHV IURP WKH UHVW RI WKH VXUIDFH > @ 3UHVHQWO\ PLFURYLULQ D PDQQR  
 ELQGLQJ OHFWLQdV OLJDQG ELQGLQJ UHVLGXHV ZHUH DVVHVVHG IRU FRQVHUYDW  
 DQG SURSHUWLHV ZKLFK UHQGHUV WKHP WR EH SRWHQWLDO ELQGHUV ZLWK  
 JO\FRSURWHLQV RI +,9 7DEOH GHSLFWV WKH OLJDQG ELQGLQJ UHVLGXHV ZLWK  
 WKH SRWHQW LQWHUDFWLRQ ZKHWKHU WKH\ FRQIRUP K\GURSKREL' FDWLRQLF S  
 LRLQLF LQ @LQNDJHV 7\U \$UJ &IV DUH UHVSQRVLEOH  
 IRU &DWLRQLF a SL LRLQLF DQG GLVXOSKLGH OLQNDJHV UHVSHFWLYHO\ +RWVSR  
 UHVLGXHV DV SUHGLFWHG FRQVWLWXWH DQG ELQGLQJ  
 UHVLGXHV FRQIHU LQWHUIDFLDO SURSHUWLHV )RXULHU WUDQVIRUP 0\$3  
 )70\$3 VFDQV DOVR FRQIHU WKH K\GURSKREL' DQG K\GURJHQ ERQG  
 LQWHUDFWLRQV DPRQJ OLJDQG ELQGLQJ UHVLGXHV RI PLFURYLULQ 7DEOH  
 H SUHVHQW DSSURDFK FRPELQDWRULDQO\ LQFOXGHV .RUWHPPH DQG %DNHU  
 ZLWK K\GURJHQ ERQG FRQWULEXWLRQ WR KRWVSRWV DQG SHUWDLQLQJ WR  
 K\GURSKREL' LQWHUDFWLRQV > @

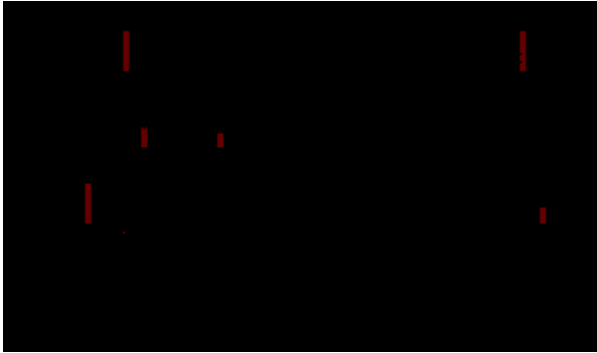
/LJDQG ELQGLQJ UHVLGXHV LQWHUDFWLRQ	
7\U	&DWLRQLF SL
\$VS	+IGURJHQ ERQG
3UR	+IGURJHQ ERQG
\$VS	+IGURJHQ ERQG
6HU	+IGURJHQ ERQG
7KU	+IGURJHQ ERQG
.OH	+IGURJHQ ERQG
/HX	+IGURJHQ ERQG
/HX	+IGURJHQ ERQG
\$UJ	,RQLF
/HX	+IGURJHQ ERQG

\$VS	
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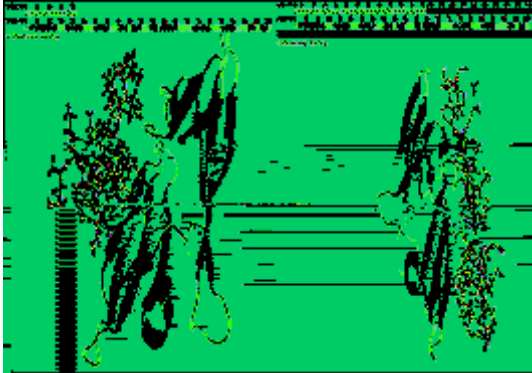
7DEOH QHUU\ YDOXH RI ELQGLQJ UHVLGXHV

5LJLG 1RQ ULJLG UHVLGXHV

)LJXUH SLFWRULDOO\ GHPRQVUDWHV LQGLYLGXDO QDWXUH RI DPLQRDFLGV L WKH OHFWLQ PLFURYLULQ )UHH HQHUJ\ EDVHG FDOFXODWLRQV ZHUH GRQH XVL \*52026d YHUVLRQ RI 6:,66 3'% 9LHZHU 1HJDWLYH GHOWD \* ZHUH UHJDUGHG VXUIDFH UHVLGXHV DQG SRVLWLYH YDOXH ZHUH FRQVLGHUHG EXULH LQ WKH SUHVHQW DQDOD\VLV 5HODWLYH DFFHVVLEOH VXUIDFH DUHD FDOFXODV UHYHDOHG WKH SUHVHQFH RI VXUIDFH UHVLGXHV )LJXUH GXH WR WKHLU SRODU XQFKDUJHG DQG QHJDWLYH QDWXUH RI DPLQRDFLGV \$V DPLQRDFLGV DUH SRVLWLYHO\ FKDUJHG K\GURSKRELF DQG SRVLWLYHO\ FKDUJHG UHVLGXHV ZHUH UHJDUGHG DV EXULHG



)LJXUH



)LJXUHRFNHG FRPSOH[HV RI PLFURYLULQ ZLWK JS DQG JS

&LWDWIDQ LYDQQDQ 3 0XUDOLWKDUDQ \* 3URELQJ 3RWHQW ,QWHUIDFLDO 5HVLGXHV  
9LVXDOLJLQJ \$QWQ #,190\$PULLYQLW 6FL 5HVGRHY

3DJH RI

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FRQVHQVXV ELQGLQJ VLWH RI WKH FRQVWUDUW 'IUDDEQW &KXEDDQ &HQFLF 5  
LPPXQRJOREXOLQ \* WKH HQHU\ ODQGVFDSHW DQDQDQDQ RFRQKHUW DQDQDQ RFRQKHUW  
LQWHUPROHFXODU LQWHUIDFH 3URWHLQV LQWHUIDFHV 3URF 1DWO \$FDG 6FL