



"#\$%&'#(!)*+,#-!.\$#/#\$!0#/%#'#!12334!5655!7!89:;!;(66<;(=6!>8!
 A(!02?@!; AAB; !CA!\$'#D+%E3&'FG!
 H/F%'&\$%3'(!!'+'!OE*4J#'FICK'!OE*4J#'FG!!MNM+\$#!).O!BB50!!!PE3/#(!BBQ<BOQ<BRAS!
 I4*+,(!#T\$E*4J#'FUV*D3F%*L#D&!
 !
 MNM+\$#!W3&'F(!9#D/#FD*-!B(66<0(66!P8X!J-!*YY3+/%4#/%
 !
 Z'*D&*%#!>FF+F%*/%CZ>G(![!])>! ! ! ! !
 ! ! ! ! !
C **D** >!/+/%'3D&\$%3/!%3!%E#!Y'+/\$+Y,#F!3N!J+3,3\-IN3'!F\$+##/\$#14*]3'F!T+%E!*!/!
 #4YE*F+f!3/!%E#!\$#,,&,*!/*%&'#!3N!,N#!L!O3/\$#Y%F!\$3V#'#D!+/\$,&D#!%E#!3' \+!/!*/D!#**',-!#V3,&%3/!
 3N!\$#,,&,*! \N#!\$#,,!F%'&\$%&'#!1N&/%3/!14#%*J3,+F4!*/D!'#Y'3D&\$%3/X!\$#,,!F+\/*,+/\X!*/D!\#/#!
 '#\&,*%3/!+/!J*\$%#'+*!*/D!#&^*-3%#FL![E#'#!*/3!Y'#'#_&+F+%F!N3'!%E+f!\$3&'F#!)HM"!1556R!,*J!
 +F!*!\$3<#_&+F+%#N3'!F%&D#/%F!TE3!E*V#!/3%*,#*D-!\$34Y,#%#D!%E*%L\$3&'F#!*/D!)HM"!15566!+F!*!\$3<
 '#_&+F+%#N3'!:'#FE4*/!) +3,3\ -!4*]3'F!C3N#'#D!:' ,!F#4#F%#*F!3/,-G
 !

M

!9#!T+,!J#!&F+/\!*!%#`%J33^!Y'3V+D#D!J-!MY#/.%*`1!*!=65C\$GCAG!/3/Y'3N+%
 \$E*`%*J,#!\$3'Y3'*%3/!*FF3\$+%#D!T+%E!2+\$#!a/+V#'F%-!+/![#`*FL!![E#!\3*,!3N!%E+f!3'*/+b*%3/!
 +F!%3!4*^#!E+\E#!'#D&\$%3/!*\$\$#FF+J,#!%3! !F%&D#/%F! [3*\$E#V#!%E+f!\3*,!%E#-!Y'3V+D#!

T+,!Y'3V+D#!-3&!*\$E*/\$#!%3!#\$#+V#!+4 4#D+*%#I#D#J*\$^!3/!-3&'!&/D#'F%*/D+/\!*/D!
+/%#'Y'##%*%+3/!3N!+4Y3'*/%J+3,3\+\$*,!Y'+/\$+Y,#F!P3,,+\!_&#F%+3/F!T+,!J#\+/\!D&'+/\!%E#!F#\$3/D!
T##^!3N!\$, *FFL!
!
c3&!T+,,!#\$#+V#!5!Y3+/%N3'!#*\$E!Y3,,!_&#F%+3/!%E*%-3&!*/FT# '!D&'+/\!\$, *FF!CJ3%E!\$3''#\$%*/D!
+/\$3''#\$%#FY3/F#F!#*'/!5!Y3+/%G!c3&!T+,,!#\$#+V#!6!Y3+/%F!N!-3&!D3!/3%#FY3/D!D&'+/\!\$, *FF!3!
N!-3&!4+FF!\$, *FFL!H%+F!

!
m ?3!J33^F!#, #\$\$% 3/+D#V+\$#F!3!'/3%#J33^F!T+,!J#!*,,3T#D!D&'+/\!#`*4F!*/D!F%&D#/%F!&F+/\!
F&\$E!+%#4F!T+,!J#!*F^#D!%3!,#*V#!*/D!T+,!'#\$#V#!*!b#`3!N3'!E#!#`*4L!!
m ?3!%*,^+/\!T+,!J#!*,,3T#D!D&'+/\!E#!#`*4!J&%F%&D#/%F!#*!Y#`4+%#D!%3!*F^!E#!+/F%'&\$%3'!
_&#F%#3/FL!!
m I*\$E!F%&D#/%D!T+,!J#!\#V#/\!*/!#`*4!%3!J#!\$34Y,##D!*/D!E*/D#D!J*\$^!%3!E#!+/F%'&\$%3'!L!!
m .%&D#/%F!4&F%J'+/\!*!Y#/\$+!* /D!T+,!%*^!%E#!#`*4!D&'+/\!%E#!F%*%#D!,\$%&'#!%#4#!3/,-L!!
m NO E c3&!T+,!E*V#!%E#!\$, *FF!%#4#!3/,-!%3!\$34Y,##%#!#*\$E!,\$%&'#!#`*4L!!
(!.%&D#/%F!FE3&,D!E*V#!+/!%E#+'!Y3FF#FF+3/!*%L*,!,!%#4#F!E#+'!e.a!F%&D#/%
+D#/%N+\$%#3/!\$*`D!!)#*\$&F#13N!E#!,*'\#F+b#13N!E#,\$*FF!E+F!F#4#F%#`!T#!T+,!J#!\$E#%^+/\!
F%&D#/%H!K!3'!*/3E#`N3'4!3N!Y+\$%&'#H!K!D&'+/\!#`*4FL!!

A FE PA [E#!: *4+, -!D&\$*%3/*,!2+\E%F!*/D!P'v*\$-\$!>\$%C: l2P>G!Y'3E+J+%F!E#!Y&J,+\$!
Y3F%#/\!3N!\`*D#F!J-IF3\$+*,!F#\$&'%-!/&4J#`!3'!+!/*-!4*//#!'Y#`F3/*,, -!+D#/%N+*J,#!%3!E#!
+/D+v+D&*,!F%&D#/%!?!3!`*D#F!\$*/J#!\#V#/\!3V#!%E#!#,#YE3/#!3'!3V#!!#4*+,J#*\$&F#!Y3F+%V#!
+D#/%N+\$%#3/!\$*/%J#!4*D#L!!

A .%&D#/%F!T+%E!D+F*J+,+%#F!TE3!#*`#Y#`#/\$+/\!J*`#F!+/!%E+F!\$3&'F#!4*-!
\$3/%*%#E#!>\$#FF!MNN+\$#N3'!*FF+F%/\$#!+/\!D#%#`4+/\!*/D!+4Y,#4#/%#/\!#*F3/*J,#!
\$\$3443D%#3/FL!E#!>\$#FF!MNN+\$#1+F!,3\$*%#D!+/:`*J*!W*,!L!E#!YE3/#!/&4J#`F!#*#!BBQ<B0=<
B0Q;!CeG!BBQ<AR=<=<;R5!CeP!*/D!BBQ<B5Q<5A0;!C[!cGL: 3'!43'#!+/\!N3'4*%#3/!Y,*#F#!V+F+%e.a0F!
>\$#FF!MNN+\$#13'!#4*+,(!*\$\$#FUV*,D3F%L#D&L!!

I e*,D3F%!.%*%#!a/v#`F%-!Ce.aG!+F!\$344+%#D!%3!\$`#*%#/\!#*!D+v#`F#!*/D!
+/\$,&F+v#T3'^!*/D!#*`+/+/\!#V+3/4#/%N'##N'34!D+F\$'+4+/*%#3/!*/D!E*`*FF4#/%L!e.a!F!
D#D+\$*%#D!%3!\$`#*%#/\!#*`/V+3/4#/%TE#`#!*,,!\$*4Y&F!\$344&/%-!4#4J#`F!N##,!V*,&#D!
'#FY#%#D!*/D!+/\$,&D#D!e*,D3F%!.%*%#!a/v#`F%-!Y'3E+J+%F!D+F\$'+4+/*%#3/!3/!%E#!J*F!3N!*\$#!
\$3,3'!%#E/+\$%-!1/!/*%#3/*,!3'+\+!1F#`!C+/\$,&D+/\!Y#`#*\/*-\$-!F%*%&F!F#`&*,!E*`*FF4#/%#*/D!F#`&*,!
V+3,#/\$#G!F#`&*,!3'#+/%*%#3/!#\#D#`!+D#/%%-!1'#,+\+3/!1*\#1/!/*%#3/*,!3'+\+!1D+F*J+,+%#-!1#/#%#D!
+/\!N3'4*%#3/!13'!V#%#`* /!F%*%&F!+!/%E#!a/v#`F%-qF!Y'3`*4F!*/D!*\$%V+%#F!#F!#_&+`#D!J-!
*YY,+\$*J,#!,*TF!*/D!#`&*,%#3/F!F&\$E!*F! [+%,#!Hr!!E#!+D+v+D&*,!D#F+/\!%#D!T+%E!'#FY3/F+J+,+%#-!N3'!
\$33'D+/*%#3/!3N!\$34Y,+* /\$#!#N3'F!*/D!#*#Y%3N!+/_&+`#F!\$3/\$#`/+/+/\!3/D+F\$'+4+/*%#3/!
Y3,+\$#F!+F!%E#!a/v#`F%-qF! [+%,#!Hr!O33'D+/*%3'(!8*\#e+v#`#%#1!K+`#%3'!3N!E#!MNN+\$#13N!.3\$+*,!
I_&+%-!1!%#,#+ UV*,3F%L#D&L!5B6;!?!P*%#`F3/!.%L!e*,D3F%!.%*%#!a/v#`F%-!1e*,D3F%*!1Z#3'\+*!
A5S6;!BBQ<AAA<=OSAL!!

C G C HB !HN!-3&!\$E33F#!%3!\$*`-!*\$3/\$#*,#D!T#*Y3/!3/!\$*4Y&F!
-3&!#*`#FY3/F+J,#N3'!^/3T+/\!*/D!N3',3T+/\!%E#!,*TL!2#N#`!E#`#N3'!:>h(!
E%YF(ddTTTTLV*,D3F%L#D&d*D4+/%#*%#3/dN+/*/\$#<*D4+dY3,+#d\$*4Y&F\$*`-d

L

BIOL

K

A F

D		C
>&\&F%5S!	. -, *J&F!	. -, *J&F!
>&\&F%5; !	[E#!. \$#/\$#!3N!) +3,3\ -!	5L5!
>&\&F%B6!	[E# 4#F!*/D!03/\$#Y%F!3N!) +3,3\ -!a/D#'F%*/D+/\!IV3,&%+3/!	5LBX!5; L5!
>&\&F%BA!	>%34F!+F3%3Y#F!+3/F!* /D!4 3,#\$&,#F!	
>&\&F%B=!		
>&\&F%BR!		

