

!"#\$%&'()\*+,-./:0123456789@ABCDEFGHIJKLMNO  
PQRSTUVWXYZ[\]^\_`{|}~!@#\$%^&\*()<=>?<=>?<=>?  
&  
&

#!\$>"3%&/%4"??&

&  
&  
3\$44+0\$!+%\$!\*?&&



&  
. @AB

&

&

#!\$>"3%&!+%/\$. +4"

*Escherichia coli*

#!\$>"3%&+/)??&



# ! \$ > " 3 % & \$ ( % 3 \$ ) " \* ? &





!"!#\$%&'()\*#\*+,-./%0-12#

32%(45-5#1.#06)#5%&'()-#2#7\*!89:\$##

!"#\$%&'()\*+,-./0'123456!'(/78'78&'#&789-'\$:9;/-&'")#&\*7/9\*&-/'\*78&'7"<%&'="\*-'  
-/)%)\$"+&- '1234'>8:9#"790:"#"'')-&\$/>7&-/'\*?/0.:&'=@A9')\$&&-'. \$'78&'\$:&%/#/\*':+'\*"%+))B'  
#&789-'(')'#9-/?/&'")89(\*/\*'7"<%&'C'79')89:7&\*78&'&7&\*7/9\*7/#&'79'CD'#/\*.'7&)%'E/0.:&'C'  
:&\$:&)&\*7)'78&'1234'>8:9#"790:"# '9<7'/\*&- '(/78'78&'#9-/?/&'-'#&789-@''

!"#\$%&'( ) \*#+\$%&, - ".%&/0''1+%23. &4. %I&5\*0&3-%&6 789: ) ; &. <. 3%=& >\*2.+.3+2/&\*5&?@& ) +\$\$+:A&"2I&  
BC'D&5\*0=+& >+I&"2I&E&&">%3\*2+30+\$%&"2I&BC'D&5\*0=+& >+IC&'FB&==& >\*4=2&G". &4. %IC&&

<b>;-&amp;)&lt;&amp;-2+0)5=#</b>	<b>&gt;(1?&lt;&amp;(@&amp;-2=#</b>	<b>3 A #</b>	<b>BA #</b>
F*7/'%"'	G@H'	=GG'	G'
HG'	G@H'	HG'	IG'
HG@G='	G@H'	J'	KJ'
HD@G='	G@H'	J'	KJ'
HD@GC'	G@H'	=GG'	G'
LC@G='	G@H'	=GG'	G'

!"#\$%&'H( ) \*#+\$%&, - ".%&/0''1+%23. &4. %I&5\*0&3-%&6 789: ) ; &. <. 3%=& >\*2.+.3+2/&\*5&?@& ) +\$\$+:A&"2I&  
BC'D&5\*0=+& >+I&"2I&E&&">%3\*2+30+\$%&"2I&BC'D&5\*0=+& >+IC&'FB&==& >\*4=2&G". &4. %IC&&

<b>;-&amp;)&lt;&amp;-2+0)5=#</b>	<b>&gt;(1?&lt;&amp;(@&amp;-2=#</b>	<b>3 A #</b>	<b>BA #</b>
F*7/'%"'	G@D'	KJ'	J'
G@MG'	G@D'	KJ'	J'
C@GG'	G@D'	IG'	HG'
D@JG'	G@D'	CJ'	IJ'
I@GG'	G@D'	J'	KJ'
M@JG'	G@D'	KJ'	J'

"  
,

"

I+/40%k'(k6789k>-0\*="3\*/0"=k\*#3"+2%Ikg+3-k3-%k=%3-\*Ik=%23+\*2%Ikg+2k!"#\$%&'Ck'FBk==k>\*\$4=2k  
G".k4.%Ikk"21k3\*3"\$k042k3+=%kG".k.JHCB'k=+243%kG+3-k3-%k5\$\*GkO"3%k\*5kBCK=\$k,%Ok=+243%k

,

I+/40%kH(k6789k,% "LkG+3-k3-%k=%3-\*Ik=\*I+5+%Ikg\*%k0%I4>%k3-%k0%3%23+\*2k3+=%k3\*kMCFk=+2CkFBk==k  
>\*\$4=2kG".k4.%Ik"21k3\*3"\$k042k3+=%kG".kMCFk=+243%kG+3-k3-%k5\$\*GkO"3%k\*5kBCN=\$k,%Ok=+243%k

"

,

**32%(45-5#1.#06)#5%&'()#-2#\*,.)'9C\*!8#**

A8&')89:7' # &789-' (")'7:"\*)?&::&- '79'2:&\$5N234'79'8";&'78&':&7&\*7/9\*'7/#&'9?'CD' #/\* .7&'")'  
 -/) \$%" +&- '/\*'7" <%&'H@'48:9# "790:" # '0?/0. :&'HP')89 ( &- '78"7'>&:7"/\*'>9# \$9\*&\*7)'9?'78&')" # \$%&'  
 )"7. : "7/\*0'78&' -&7&>79: @'A9'0&7'78&'099- '-&7&>79:':&)\$9\*)&B'?%9 ( '>&%%' (") '>8"\*0&- '79'9\*&' (/78'  
 G@J # # '\$"78'%&\*078@'A8&'>8:9# "790:" # '9<7"/\*&- ' (/78'\*& ( '?%9 ( '>&%%B'?/0. :&'LB')89 ( &- '\*9'  
 )"7. : "7/9\*'9?' -&7&>79:'<. 7'78&'\$&"Q' - .&'79'"7&:'&% .7/\*0'>9# \$9\*&\*7)'0 ( 8/>8"":&'9. :. )" # \$%&)'9?'  
 /\*7&:&)'>9\*?/: # &- '<+': . \*\*/\*0'/\*' 6 !P"'&')9') # ""'78"7'78&+'":&'<":&'+';/)/<%&'/\*'78&'  
 >8:9# "790:" # @'

"

,

,

$I_{+}/40\%K(9-0^{*}="3^{*}/0^{*}="50^{*}="70\%, :O789C4\%3^{*}-+/-k^{*}="423.k^{*}5k^{*}23^{*}="11.0K23k, 0\%. \%23k+2k0k^{*}="85$



"

#

\* ,)0,) %0&)20#1.#06)#5%&' ()#

A8&'>9 # \$%&U/7+'9?'78&') " # \$%&' ( " )'?:)7') / # \$%/?/&- ' . ) / \* 0' & U7: ">7/9\* ' # & 789 - @ ' D G V ' ; W ; "' > & 79\* / 7: / % & ' / \* ' ( " 7&: ' ( " ) "' - - & - ' 79' 78&') " # \$%&' " \* - ' ) 9\* / > " 7& - ' ? 9: ' H G ' # / \* . 7& ) @ ' A 8&') " # \$%&' ( " ) ' 78&\* ' > & \* 7: / ? . 0 & - ' " 7' = C G G U 0 ' ? 9: ' J ' # / \* . 7& ) @ ' A 8&') " # \$%&' ( " ) ' 9 < ) & : ; & - ' 79' ) & \$ " : " 7& ' / \* ' 7 ( 9 ' % " + & : ) X ' . \$ \$ & : ' > % & " : ' % " + & : ' ( / 78' ) 9 # & ' 9 ? ' 78& ' - / ) ) 9 % ; & - ' ) " # \$%&' " \* - ' % 9 ( & : ' ; / ) > 9 . ) " % " + & : ' ( / 78' . \* - / ) ) 9 % ; & - ' ) " # \$%&' @ ' A 8& ' . \$ \$ & : ' % " + & : ' ( " ) ' > 9 % % & > 7 & - B ' " \* - ' % 9 ( & : ' % " + & : ' ( " ) ' "

I+/40%N(6789, %'L\*5d3-%k. "=, \$%k. %, "0"3%I&G+3- &NBDSQTQUk ">%3\*2+30+\$%k+2&G"3%0Ck; "=, \$%k  
I+..\*\$Q%I&+2&NBDSQTQUk ">%3\*2+30+\$%k+2&G"3%0k "2I&>%230+54/%I&5\*0&F&=+243%. &"3k 'HBB&V/C&  
62I+..\*\$Q%I&. "=, \$%. @k. %, "0"3%I&". &\$\*G%0&\$ "<%0&G". &+. \*\$ "3%I& "53%0&5+Q%&0\*42I. &\*5&G". -+2/@&  
"2"\$<W%I& "2I&5\*42I&3\* &>\*23" +2&2 \* &\*0&Q%0<&\$+33\$%&\*40k. "=, \$%. &\*5&+23%0%. 3C&

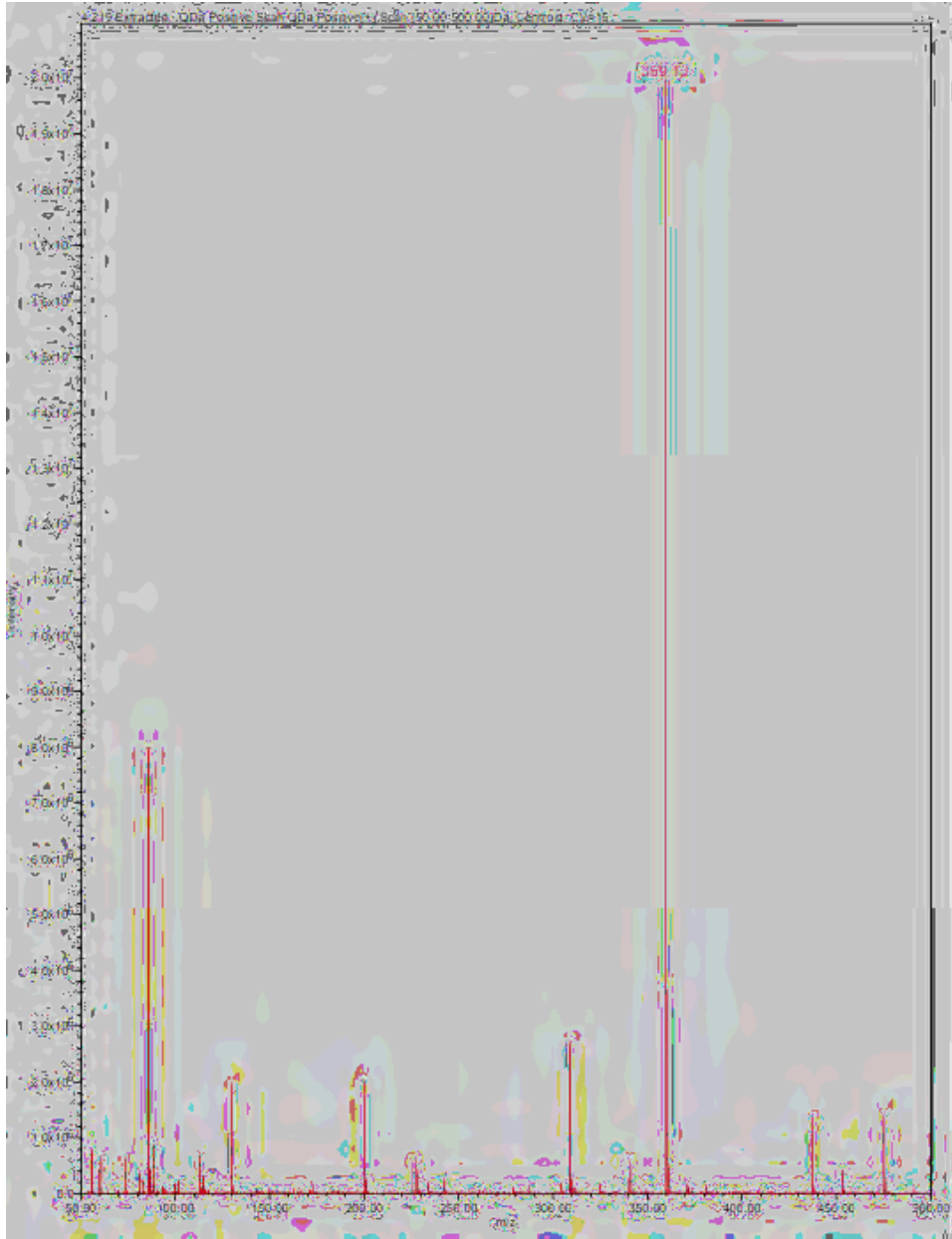
**\*+,-./%0-12#1.#7' '),#\$+',)2%0%20#!%4),#+5-2D#\*,) '9C\*! 8#**

Y?&:'>9\*?/: #/\*0' (/8' 1 2 3 4 5 6 !'78"7'9.:)' # \$%&)'9?/\*7&:&)7'8";&'<&&\*>9# \$%&7&%+':&>9; &:&- /'\*'  
.\$\$&:'). \$&:\*"7"\*7%" +&:'?&:'?9.:':9. \*-)'9?' (")8/\*0B'/7' (")'78&\*'\$. :/?/&-'.)/\*0'2:&\$5N234@'  
T":/9.)?:">7/9\*)' (&:&'>9%%&>7&- "'\*-' (&:&'")9""\*"%+, &- '9\*78&""\*"%+7/>"%' 1 2 3 4 5 6 !'79'  
-&7&: #/\*&' ( 8/>8'?: ">7/9\*)'79'. )&'?9:'?.:78&:'\$. :/?/>"7/9\*9?'78&'>9# \$9. \*-)'9?/\*7&:&)7@! 9#&'  
?: ">7/9\*)'>9\*7'/\*&- '#9:&78"\*9\*&)' # \$%&)'9?/\*7&:&)7' ( 8/>8'). 00&)7)'78"7')&>9\*-'\$. :/?/>"7/9\*'/)'  
\*&&-&-@''

I+/40% X(70%, :O789<-0\*="3\*/0"=d\*5t>\*\$\$%>3%I4, ,%0d\$ "<%0Ck I\$\*Gt>%\$\$t\*5t, "3-d\$%2/3-dHk==d  
G".d4.%ICdY"0+\*4. d50">3+\*2.dG%0%>\*\$\$%>3%I3\*d"2"\$<W%>\*2t"2"\$<3+>"\$d 6789: ) ;C&d

,

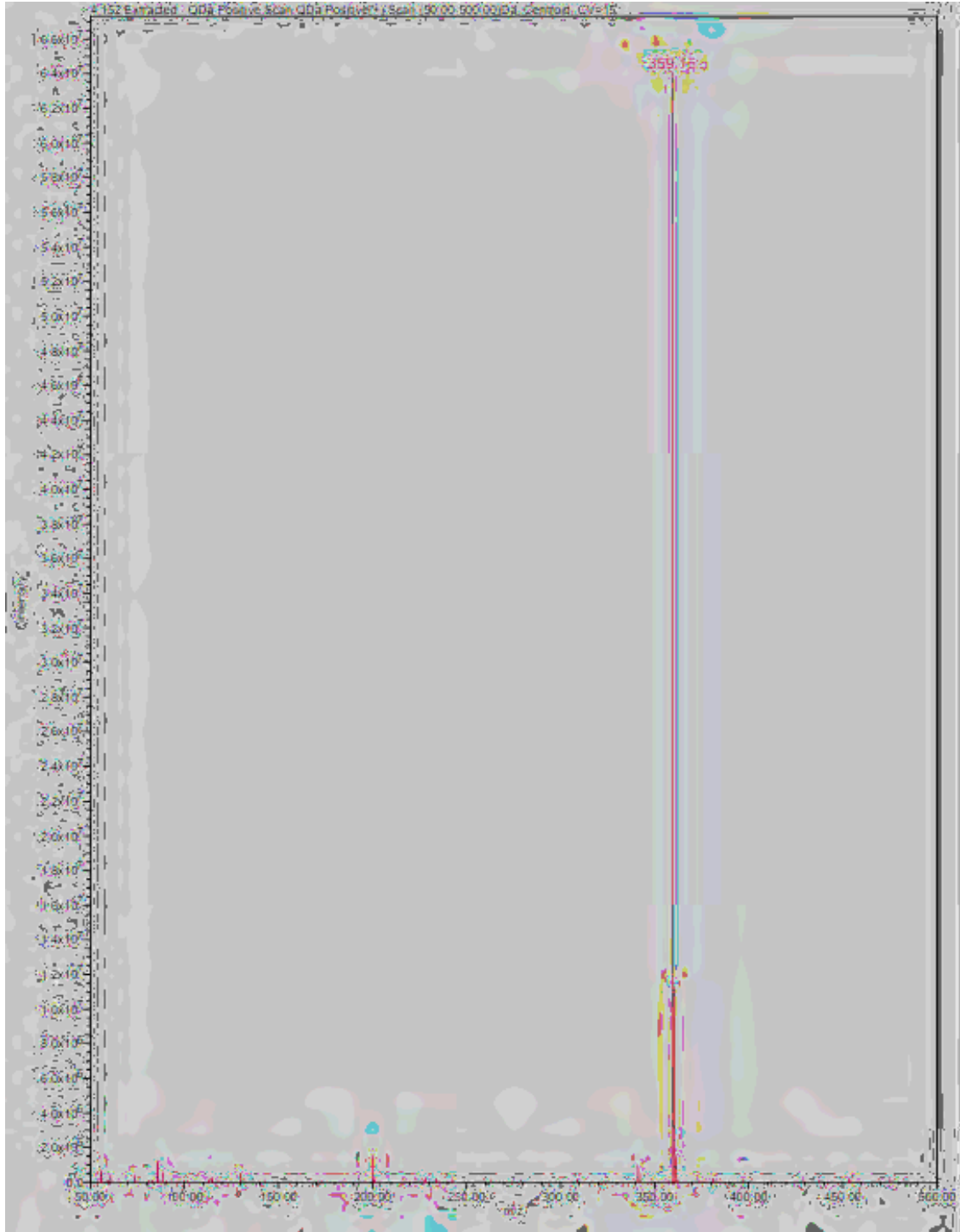
$I_{+}/40\%M(6789k > -0* = "3*/0" = k*5k50" > 3+*2k'k. - *G+2/k, \% "Lk*5k = TWZkKF[C'Kk$



$I + 40\% \left[ \frac{d}{d} \right]; d., \% > 30 \text{ "d\%V30"} > 3\% I \text{ d}50^* = \text{d}50'' > 3 + *2 \text{ d}' \text{ d} * 5 \text{ d} > * = , *421 \text{ d}G+3 - \text{d}3 - \% \text{d}0\%3\%23 + *2 \text{ d}3 + \% \text{d} * 5 \text{ d} JCHH \text{ d}$   
 $= +243\% \text{ d}$

"

*I+/40%k*



$I + 40\%k''(k)$ ;  $k, \% > 30\%V30'' > 3\%I \& 50 * = \& 50'' > 3 + * 2 \& H \& * 5 \& > * = , * 42 I \& G + 3 - \& 3 - \% \& 0 \% 3 \% 2 3 + * 2 \& 3 + = \% \& * 5 \& JCHM' \&$   
 $= + 24 3 \% C \&$

$I + /40\%k 'H(k) ; k. , \%>30''k\%V30''>3\%I&50*=\&50''>3+*2&H&*5k>*=\ , *42I&G+3 - \&3 - \%&0\%3\%23+*2&3+=\%&k*5&JCJFX&$   
 $=+243\%&k$



I+/40%K(6789>-0\*="3\*/0"=550">3+\*2Kd.-\*G+2/d,%L.d\*5d=TWZKF[CHBC"21d=TWZKMFC'[d

"

$I + \frac{40}{100} J(k) ; k. , \% > 30 " k \% V 30 " > 3 \% I k 50 * = k 50 " > 3 + * 2 k K k * 5 k > * = , * 4 2 1 k G + 3 - k 3 - \% k 0 \% 3 \% 2 3 + * 2 k 3 + = \% k * 5 k J ' F [ k$   
 $= + 2 4 3 \% k$

"

I+/40%&'F(& ) ;&. , %>30"&%V30">3%I&50\*=&50">3+\*2&K&\*5&>\* = , \*421&G+3 - &3 - %&0%3%23+\*2&3+=%& \*5&JCJ 'J&  
=+243%&

I+/40%k 'N(d6789k>-0\*="3\*/0"=k\*5k50">3+\*2kJk. -\*G+2/k,% "L. k\*5k=TWZKMFCH '@k=TWZkKMXCHJk"21k  
=TWZJ 'KCHFk

I+/40%k 'X(k) ; k. , %>30" &%V30">3%I&50\*=&50">3+\*2&J& \*5&>\* = , \*42I&G+3 - &3 - %&0%3%23+\*2&3+=%&&\*5&JCJH[&  
=+243%&

"

I+/40%&'M( ) ;&. , %>30''&%V30''>3%I&50\*=&50''>3+\*2&J&\*5&>\* = , \*42I&G+3 -&3 - %&0%&3%23+\*2&3+ = %&\*5&JCMNK&  
=+243%&

"

$I + /40\% \text{ ' } [( \text{ \& } ) ; \text{ \& } . , \% > 30 \text{ " \& \% V30 \text{ " } > 3\% I \& 50 * = \& 50 \text{ " } > 3 + * 2 \& J \& * 5 \& > * = , * 42 I \& G + 3 - \& 3 - \% \& 0 \% 3 \% 2 3 + * 2 \& 3 + = \% \& * 5 \& FCBNN \&$   
 $= + 243 \% \&$

,

I+/40%kHB(k6789k>-0\*="3\*/0"=k\*5k50">3+\*2kFk.-\*G+2/k,% "Lk\*5k=TWZJ'KCHFk



"

$I + /40\% \text{H}'(k) ; k. , \% > 30'' \text{V}30'' > 3\% I \text{d}50^* = \text{d}50'' > 3+ *2 \text{d}F \text{d}^* 5 \text{d} > * = , *421 \text{d}G+3 - \text{d}3 - \% \text{d}0\% 3\% 23+ *2 \text{d}3+ = \% \text{d}^* 5 \text{d} \text{FCBJF} \text{d}$   
 $= +243\% \text{d}$

,

,

,

>+0+,)# E 1,F5##

!&>9\*-'\$.:/?/>"7/9\*'9?'78&'?:">7/9\*' ( 9.%-'<&'\$&:?'9:#&-' '\*-' '\*"%+,&-'9\*' '\*"%+7/>"%'  
1 2 3 4 5 6 !"

Y%%')"# \$%&)' (/%%'78&\* '<&'). <L&>7&- '79'""9:&# &\*7/9\*&- '\$:9>&))'79'\$ .:/?+'9.:')"# \$%&)'9?'  
/\*7&:&)7@''

1 \$\$&:' '\*-'39 ( &:'%"&+&:' (/%%'78&\* '<&' '\*"%+,&- ' (/8'78&'%9\*0' # &789-'78"7' (&'8";&'79'  
>9\*?/: # '>9# \$%&7&':&>9;&:+ '9?'9.:')"# \$%&)'9?'/\*7&:&)7@''

A (9')7&\$'\$ .:/?/&- '?:">7/9\*)' (/%%'?'/\*"%%+ '<&' '\*"%+,&- '9\*' 1 2 3 4 5 6 !'. )/\*0'%9\*0' # &789-'79'  
8";&'<&77&:')&\$": "7/9\*'9?'78&'\$&"Q)' '\*-' '\$.:/7+'>9\*?/: # "7/9\*@'

#

**G10)##**A8&'%9\*0' # &789-' 1 2 3 4 5 6 !'0/;&)'<&77&:':&)9%.7/9\*'9?'\$&"Q)'<.7'9:'\$:&%/#/\*":+)7&\$)'9?'  
\$.:/?/>"7/9\*'79)\$&&-'. '\$78&' '\*"%+ )/B' (&'& ;&%9\$&-')89:7' # &789-'9\*' '\*"%+7/>"%' 1 2 3 4 5 6 !'E/\*"%'  
" '\*"%+ )/)'9:'78&'\$ .:/?/&-')"# \$%&)'9?'/\*7&:&)7' (/%%'<&' '\*"%+,&- '. )/\*0'%9\*0' # &789-@''

,