

! "#\$%&'(\$%-%
% %

) *+,#\$,-%./0%1213

Joe Phua, Ph.D.

4 *\$5678%9:"66;%6<%"*%=,(8%
96#"*,>%4*("65'8(%?>'@*,8'(-%
? AB",*-%C**%D*>(*,0%EE22%F-*,%9(GO%
F\$;;\$80%HI%JK12K%
!"6>*L%M1.3N%JOPQO.EE%
RA\$';%L%\$B"#T8A#C*5#%

%
!"GF0%
%
4G=GO%
%
VG=GO%
%

0%12..0%D6AA#>:'\$('6>%

0%12230%D6AA#>:'\$('6>%4\$>\$U*A*>(%

0%12210%D'>*A\$%\$>5%4*5'\$9(#5'*8%

F',*:(6,0%H*A*;',>%=5@*,'8'>U%W>8'(#(*0%4*\$5678%9:"66;%6<%"*%=,(8%M)\$;,%1211%

! "#\$%&'(\$%1%

) *+,#\$, - . / 0%1213

%

=88'8(\$>(!,6<*886,%MH*>#,*Q(,\$:\NO%F*B\$(A*>(%6<%=5@*,'8'>U%\$>5%!#+:':%
Y*;\$('6>80%Z,\$5-%D6;;*U*%6<[%6#,>\$;'8A%\$>5%4\$88%D6A A#>':\$('6>%M)\$;,%12..%X%
9B,'>U%12.JN%

%

H6B%!\$B* ,%=7\$,5%12110%=7\$,5*5%+-L%=886:\$('6>%<6,%R5#:\$('6>%>[6#,>\$;'8A%
\$>5%4\$88%D6A A#>':\$('6>%M=R[4DNO%=5@*,'8'>U%F'@'8'6>G%

%

Y*8*\$,:("%)*;;678"B%D6AB*('6>%=7\$,5%121.Q12110%=7\$,5*5%+-L%=A*,':\$>%
=: \$5* A -%6<%=5@*,'8'>U%M===NG%

%

V*8(=%,('::*%=7\$,5%12.P%6<][6#,>\$;%6<%W>(*,\$:(@*%=5@*,'8'>U^0%=7\$,5*5%+-L%
=A*,':\$>%=:\$5* A -%6<%=5@*,'8'>U%M===NG%

%

_6#>U%9:"6;\$,%=7\$,5%12.P%M`6A'>*%NO%W>(*,>\$('6>\$;%D6A A#>':\$('6>%=886:\$('6>%
MWD=NG%

%

H6B%!\$B* ,%=7\$,5%12.00%=7\$,5*5%+-L%W>(*,>\$('6>\$;%D6A A#>':\$('6>%=886:\$('6>%
MWD=NO%9B6,(8%D6A A#>':\$('6>%W>(*,*8(Z,6#BG%

%

F'88*,\$('6>%6<%("%_*\$,%=7\$,5%12.10%=7\$,5*5%+-L%W>(*,>\$('6>\$;%D6A A#>':\$('6>%
=886:\$('6>%MWD=NO%\$>5%`\$('6>\$;%D6A A#>':\$('6>%=886:\$('6>%M`D=NO%a*\$;(" %
D6A A#>':\$('6>%F'@'8'6>8G%

%

9#A A * ,%F6:(6,\$;%9:"6;\$,8"B%12.20%=7\$,5*5%+-L%bc<6,5%W>(*,>*(%W>8('(#(*%M b WWNO%
?>'@* ,8'(-%6<b c<6,50%bc<6,50%?>'(*5'd'>U56AG%

%

&'8'(>U%9:"6;\$,%)*;;678"B%12.20%=7\$,5*5%+-L%9'>U\$B6,*%W>(*,>*(%Y*8*\$,: "%
D*>(*,%M9YDNO%`\$>-\$>U%H*:">6;6U':\$;%?>'@* ,8'(-0%9'>U\$B6,*G%

%

H6B%9(#5*>(! \$B* ,%=7\$,5%122/0%=7\$,5*5%+-L%`\$('6>\$;%D6A A#>':\$('6>%
=886:\$('6>%M`D=NO%a#A\$>%D6A A#>':\$('6>%\$>5%H*:">6;6U-F'@'8'6>G%

%

H6B%9(#5*>(! \$B* ,%=7\$,5%122PO%=7\$,5*5%+-L%W>(*,>\$('6>\$;%D6A A#>':\$('6>%
=886:\$('6>%MWD=NO%W>(*,U,6#B%D6A A#>':\$('6>%W>(*,*8(Z,6#BG%

%

%

?>'@* ,8'(-%6<Z*6,U'\$0%Z,\$>(%F*@* ;6BA*>(! ,6U,\$A% ! \$,(':'B\$>(%12.3Q12.00%
b7*>8%W>8('(#(*%<6,%V*"\$@'6,\$;%Y*8*\$,: "%M b WVYNG%

%

?>'@* ,8'(-%6<Z*6,U'\$0%D"\$,; *8%VGd>\$BB%R\$,;-D\$,** ,%9:"6;\$,%=7\$,5%12.0%
M`6A'>*%NO%?>'@* ,8'(-%6<Z*6,U'\$Y*8*\$,: "%)6#>5\$('6>%M?Z=Y)NG%

! "#\$%&'(\$!E%

) *+,#\$, -% . / 0%1213

% %

%%

?>'@*,8'(-%6<%Z*6,U'\$0%C';;-H*\$:" '>U%) *;;67%12.1Q12.30%D*>(*,%<6,%H*\$:" '>U%\$>5%
C*\$,\$>'>U%MDHCNG%

%

?>'@*,8'(-%6<%96#(" *,>%D\$;<6,>'\$0%Y*8*\$,: "%=7\$,5%<6,%W>(*,>\$('6>\$;%F'88* ,(\$('6>%
9(#5-%12.2Q12..0%=>*+*,U%9:" 66;%<6,%D6A A#>':\$('6>%\$>5% [6#,>\$;'8AG%

%

?>'@*,8'(-%6<%96#(" *,>%D\$;<6,>'\$0%F6:(6,\$;%9(#5'*8%) *;;678" 'B%=7\$,5%1220Q12..0%
=>*+*,U%9:" 66;%<6,%D6A A#>':\$('6>%\$>5% [6#,>\$;'8AG%

[Note: * denotes undergraduate or graduate co-authors at the time research was conducted; ISI Web of Science Impact Factor in parentheses.]

G C C (F 19, 2024):

: 6,010 - : 28, 10- : 40

(0)

%

.G% ` \6;>\$\6#0=>U*;' \0% 0%\$>5%R#>%966\d76>%M! , *88NG% e "\$(%
F,'@*8%=55' ;6>%6>%96:'\$;%4 *5'\$%9>(*8f%H" *%Y*;\$('6>8" 'B8%+*(7**>%
!8-:"6;6U':\$;%e *;;QV*'>U%9(\$(*80%96:'\$;%4 *5'\$%=55':('6>0%V,\$>5%=55':('6>0%
\$>5%W AB#;8*%V#-'>U%6>%96:'\$;%4 *5'\$G% %
g121. %W AB\$:(%) \$:(6,L%PG /KJh%

%

1G% C**0%_>QW0%_'>UQD "\$%a8#i0%

0%H\$'Q_**%e #0%\$>5%9\$,\$"a\$:" A\$>i%

! "#\$%&'(\$3%
% %

) *+,#\$, -% . / 0%1213

OG% , 0%\$>5%F6>U%[\$*%C'Ai%M121ENC%D\$>% e \$,>>U%;\$+*;8%A>('U\$(*%
R<<*: (8%6<%=5@* ,('8'>U% 4 *88\$U*%D;\$'A8%'>%D*; *+,'(-QR>56,8*5%W>8(\$U,\$AQ
V\$8*5%R;*:(,6>':%D'U\$, *((*%=5@* ,('8* A *>(8f%W><#*>: *%6>%96:'\$;% 4 *5'\$%
?8*,8j%RQD'U\$, *((*%=(('5*8%\$>5%V* "\$@'6,\$;%W>(*>('6>8G%
MKNO%3KKQ3JK %

JG% !<*#<<*,0%*=;*c\$>5*,0%\$>5% %M1211

! "#\$%&'(\$%0%
% %

) *+,#\$, -% . / 0%1213

11G% , 0% [" " Q9-#\$>%C'>0%\$>5%F6>U%[\$*%C' A i%M12.PNG?>5*,8(\$>5'>U%
D6>8#A*,%R>U\$U* A*>(%7'("%D*;*+,'(-QR>56,8*5%RQD'U\$,*((%=5@*,'8'>U%
6>%W>8(\$U,\$AG% 0%/EQ.21G%
g121.%WAB\$:(%)\$:(6,L%PG/KJh%

%

1EG% , 0% !6QC'>%!\$>0%\$>5%d#\$>Q[#%D"*>i%M12.PNG%9B6,(%H*\$A

! " # \$ % & ' (\$ %

) * + , # \$, - % . /

! "#\$%&'(\$%/ %

) *+,#\$, - % . / 0%1213

%

%

%

33G%['>0%9*#>U\$%&*>#80%\$>5% %M12.3NG%)6;;67'>U%D*;*+,'('8j%H7** (8%
 \$+6#(%V,\$>58L%H"*%W AB\$:(%6<%H7'((* ,QV\$8*5%R;*:(,6>' :% e 6,5Q6<Q 4 6#(" %
 M* e 64 N%6>%D6>8#A *,8j%96#,:*%D,*5'+';(-! *,:*B('6>0%V#-'>U%W>(*>'6>0%
 \$>5%96:'\$;%W5*>('<:'\$('6>%7'("D*;*+,'('8G% M1N0%
 .P.Q./KG%
 g121.%W AB\$:(%)\$:(6,L%OGK1Ph%
 %

%

3KG% , %M12.ENG!\$,'(:'B\$(>U%'>%a*\$;\$(" %W88#*Q9B* :<':%96:'\$;%`*(76,\>U%
 9'(*8%M9`98N%(6%k#'(9A6\>UL%a67%56*8%b>:'> *%96:'\$;%
 W>(*,:6>>*:(*5>*88%><;#*>:*%9A6\>U%D*88\$('6>%9*;<QR<<':\$:-f%
 MKNO%/EEQ/K1G%%
 g121.%W AB\$:(%)\$:(6,L%KGJK2h%

30G% , %M12.ENG%H"*%Y*<*,*>:*%Z,6#B%!*,8B*:(@*%<6,%9A6\>U%
 D*88\$('6>L%=>%Rc\$A'>\$('6>%6<(" %W><;#*>:*%6<%96:'\$;%`6,A8%\$>5%96:'\$;%
 W5*>('<:'\$('6>%7'("Y*<*,*>:*%Z,6#B%6>%9A6\>U%D*88\$('6>%9*;<

! "#\$%&'(\$%. 2%
% %

) *+,#\$, -% . / 0%1213

L%

0%H" 6#8\$>5% b\$\80%D=L%9\$U*0%

J12QJ1PG%

(1)

.G% !<*#<<*,0%=;*c\$>5*,0% 0%\$>5% 4\$,';->%!, 'A6@': i%M1213NG%H,#8(%+#(%
9:,#('>'n* f%Q%

! "#\$%&'(\$% . . %
% %

) * +, # \$, - . / 0 1 2 1 3

0% 9(G%

! * (*, 8 + #, U 0%) C 0% 4 \$, : "% 1 2 1 1 G!

! PG% ! < * # < < *, 0% =; * c \$ > 5 * , 0% 0% \$ > 5 % 4 \$, ; - > % ! , ' A 6 @ ' : i % M 1 2 1 . N G % H, # 8 (' > U % 6 > %
\$ % e " ' A f % = % 4 #; (' Q 4 * (" 6 5 % W > p #', - % 6 < % D # * Q V \$ 8 * 5 % H, # 8 (' > % b > ; ' > * % D 6 > 8 # A * , %
! , 6 5 # : (% Y * @ ' * 7 8 G %
& ', (# \$; 0% [# > * % 1 2 1 . G!

! / G% C '# 0% [' \$ - ' > U 0% 0% F * \$ > % d, # U A \$ > 0% C ' > S ' \$ % I # i 0% Z, * > % ` 6 7 \$ \ 0% \$ > 5 % C # : - %
! 6 B 6 @ \$ % M 1 2 1 . N G % F 6 % _ 6 # > U % = 5 #; (8% = ((* > 5 % (6% a * \$; (" % e \$, > > U 8 % > (" * %)', 8 (%
W k b 9 % = 5 @ * , (' 8 * A * > (' > % (" * % ? G 9 G f % = > % R - * Q H, \$: \ ' > U % = B B, 6 \$: " G %
& ', (# \$; 0% 4 \$ - % 1 2 1 . G!

! . 2 G% ! < * # < < *, 0% =; * c \$ > 5 * , 0% \$ > 5 % % M 1 2 1 . N G % 9 (, \$ > U * , F \$ > U * , f % D # * Q + \$ 8 * 5 %
H, # 8 (' > % b > ; ' > * % D 6 > 8 # A * , % ! , 6 5 # : (% Y * @ ' * 7 % & ' 5 * 6 8 G %
& ', (# \$; 0% 4 \$, : "% 1 2 1 . G!

! . G% ` \ ' 6 ; > \$ \ 6 # 0% = > U * ; \ ' 0% \$ > 5 % % M 1 2 1 . N G % e " \$ (% A \$ \ * 8 % \$ % C 6 - \$; %) \$ > % \$ %
V, \$ > 5 % = 5 @ 6 : \$ (% 6 > % 9 6 : \$; % 4 * 5 ' \$ f % D \$ B' (\$; ' n ' > U % 6 > % V, \$ > 5 % ! \$ U * C 6 - \$; (- % (6
+ # ; % 9 * ; < Q R c B \$ > 8 ' 6 > % V * > * < ' (8% < 6, %) \$ > 8 G %
& ', (# \$; 0% 4 \$, : "% 1 2 1 . G%

! . 1 G% ! , ' A 6 @ ' : 0% 4 \$, ; - > i 0% \$ > 5 % % M 1 2 1 2 N G % D 6 A B \$, ' > U % R c B * : (\$ > : - %
& ' 6 ; \$ (' 6 > 8 % D 6 A A' ((* 5 % + - % W > < ; # * > : * , % = 5 @ * , (' 8 ' > U % 9 6 #, : * 8 % 6 > 9 6 : \$; % 4 * 5 ' \$ G %
9 \$ > %) , \$ > : ' 8 : 6 0 % D = 0% = # U # 8 (% 1 2 1 2 G %

! . E G% d ' A 0% [' " 6 6 > i 0% 0% ` \$ " % Y \$ - a \$ > i 0% \$ > 5 % H \$ * - * 6 > % d ' A i % M 1 2 1 2 N G %
W > @ * 8 (' U \$ (' > U % (" * % W A B \$: (% 6 < % W A A * , 8' @ * % = 5 @ * , (' 8 ' > U % 6 > % = ((' (# 5 * % (6 7 \$, 5 % (" * %
V, \$ > 5 % L % H " * % 4 * 5 ' \$ (' > U % Y 6 ; * 8 % 6 < ! * , : * ' @ * 5 % ` 6 @ * ; (- 0% ! * , : * ' @ * 5 % W > (* , \$: (' @ ' (-
\$ > 5 % = ((' (# 5 * % (6 7 \$, 5 % (" * % = 5 @ * , (' 8 * A * > (%
9 \$ > %
) , \$ > : ' 8 : 6 0 % D = 0% = # U # 8 (% 1 2 1 2 G %

! . 3 G% , 0% 9 * # > U \$ % & * > # 8 % [' > % \$ > 5 % [' " 6 6 > % d ' A i % M 1 2 1 2 N G % ! , 6 Q & * U \$ > ' 8 A % 6 > %
W > 8 (\$ U, \$ A L % R < < * : (8% 6 < ? 8 * , Q Z * > * , \$ (' 5 % D 6 > (* > (% \$ > 5 % 4 * 8 8 \$ U * % R > 5 6, 8 * , %
H - B * 8 % ' > % W > 8 (\$ U, \$ A Q V \$ 8 * 5 % ! , 6 Q & * U \$ > ' 8 A % ! 6 8 (8 G %
% Z 6 ; 5 % D 6 \$ 8 (0%
= # 8 (, \$; \$ 0% 4 \$ - % 1 2 1 2 G %

! . K G% a \$ > 0% ` \$ " % Y \$ - i 0% \$ > 5 % [' " 6 6 > % d ' A i % M 1 2 1 2 N G % R > : 6 #, \$ U ' > U % R > * , U - %
9 \$ @ ' > U % (" , # 6 U " %) \$: * + 6 6 \ L % R < < * : (% 6 < 4 * 8 8 \$ U * % D 6 > : , * (* > * 8 8 % \$ > 5 % 4 * 8 8 \$ U * %
9 * > 5 * , F ' 8 (\$ > : * % 6 > % D 6 > 8 # A * , % = ((' (# 5 * 8 % \$ > 5 % V * " \$ @ ' 6, \$; % W > (* > (' 6 > 8 G %
0% 9 \$ > % F ' * U 6 0%
D = 0% 4 \$, : "% 1 2 1 2 G %

! "#\$%&'(\$% . 1%
% %

) *+,#\$, -% . / 0%1213

.0G% , 0%9*#>U\$%&*>#8%['>%\$>5%['"66>%d'Ai%M12./NG%W>(*,\$:('6>%R<<* : (%
6<%96#, : *%H-B*%\$>5%4 *88\$U*%&\$; *>: *%'>%W>8(\$U,\$AQ+\$8*5%=5@* , ('8'>U%
4 *88\$U*8%\$+6#(%&*U\$>'8AG%

! "#\$%&'(\$%. E%

) *+,#\$, -% . / 0%1213

% %

13G% , 0%\$>5% ['"66>%d'Ai%M12.PNG%9(\$, '>U%'>%_6#, %b7>%9>\$B: "\$(%
=5@* ,('8* A*>(L%W><;#* >: *%6<%9* ;<QV,\$>5%D6>U,#'(-0%9* ;<QY* <* , * >: '>U%'>5%
! * , : * '@*5% a#A6, %6>%V, \$>5% (('#5* %\$>5% ! #, : "\$8* %W>(*>('6>%6<%=5@* , ('8*5%
V, \$>58G%
' * 7%_6, \0%` _0% 4\$, : "%12.PG%

%

1KG'D\$A * ,6>0%d, '8(*>i0% 0%\$>5%9B*>: * ,%H'>\ "\$A%M12.PNG%H" *%R<<* : (%6<%
! 6; (' : \$; %D\$>5'5\$(*%=#(" * >(' : (-%\$>5%96#, : *%D, *5'+; '(-%6>%&6('>U%V* "\$@'6, %
'>(" * %12.0%?G9G% ! , *8'5*>('\$; %R; * : ('6>L%4 *88\$U*0%4 *5'\$0%\$>5%H\$, U* ('>U%
WAB; '\$('6>8%<6, %=5@* , ('8'>U! , \$: (' : *G%
' * 7%_6, \0%` _0% 4\$, : "%12.PG%

%

10G% , 0% ["' "Q9-#\$>%C'>%\$>5%F6>U% [\$*%C'Ai%M12.JNG%Rc\$A'>'>U%RQ
: 'U\$, * ((* %=5@* , ('8'>U%(" ,6#U"%96: '\$; %4 *5'\$L%R<<* : (8%6<%D6>8#A * , QD* ; * +, '(-%
Y'8\Q

! "#\$%&'(\$%. 3%

) *+,#\$, -% . / 0%1213

% %

%
 E1G% , 0%9*#>U\$%&* >#8% ['>0%\$>5% [' "66>%d' A i %M12.ONG%?8*8%\$>5%
 Z,\$('<':\$('6>8%6<%96:'\$;% ` *(76,\ '>U%9'(*8%<6,%96:'\$;D\$B'(\$;L%D6AB\$, '>U%
)\$: *+66\0%H7'((* ,0%W>8(\$U,\$A0%\$>5%9>\$B: "\$(\$G%
 0%)#\#6\0%[\$B\$>0%[#>*%12.0G%

%
 EEG%! \$>0% !6QC'>0% 0%\$>5%D"\$>U% e \$>% e 66%M12.ONG% ! * , : *'@*5%V,\$>5%
 ! * ,86>\$;'(-%(" ,6#U"%9B6,(8%9B6>86,8" 'BL%C6:\$('>U%\$%V;#,, *5%C'>*%+*(7* * >%
 R>(*,(\$>A * >(\$>5% ! * ,8#\$8'6>% '>4 *5'(\$*5%9B6,(8G%
 0%)#\#6\0%[\$B\$>0%

[%>*%12.0G%

%

%
 E3G% , 0%9*#>U\$%&* >#8% ['>0%\$>5% [' "66>%d' A i %M12.ONG%Z,\$('<':\$('6>8%6<%
 #8'>U%)\$: *+66\0%H7'((* ,0%W>8(\$U,\$A0%\$>5%9>\$B: "\$(%(6%<6;;67%V,\$>58L%
 W><;#* >: *%6>%V,\$>5%D6A A#>'(-

! "#\$%&'(\$% . K%
% %

) *+,#\$, -% . / 0%1213

32G% , 0%

! "#\$%&'(\$% . J%
% %

) *+, #\$, -% . / 0% 1213

KJG% , %M122/NG%9B6,(8%) \$>8j% ? 8 *% 6<%) \$: * +66 \ % 9B6,(8% Z,6#B8% \$>5%
=BB;' :\$('6>8L%W AB;' :\$('6>8%<6,%V,'5U'>U\$>5% \V6>5'>U% 96 : '\$,%D\$B'(\$;G%

D "' : \$U60%

W; ; '>6'80% ` 6@ * A+ * ,% 122/G%
%

! "#\$%&'(\$. P%
% %

) *+,#\$, -% . / 0%1213

! ,6U,\$A%R5#:\$('6>%M9 ` = !QR5N0^%) _12.K0%D6Q!, '>:'B\$;%W>@*8('U\$(6,0%
!,6S*:(%qL%31J22Q232Q22222E201/

?>'(*5%9(\$(*8F*B\$, (A*>(%6<%=U,':#;(#, *M?F9=NO%) 665%\$>5% ` #('6>%9*,@':*0%Z=%
F*B\$, (A*>(%6<a#A\$>%9*,@':*80%]Z*6,U'\$9#BB;*A*>(\$;% ` #('6>%=88'8(\$>: *%
! ,6U,\$A%R5#:\$('6>%M9 ` = !QR5N0^%) _12.K0%D6Q!, '>:'B\$;%W>@*8('U\$(6,0%
!,6S*:(%qL%31J22Q232Q22222E201/

%

()

\$3 , 2

?>'@*,8'(-%6<Z*6,U'\$0%=F!Y%)\$:#;(-%=5%a6:%9* *5%Z,\$>(0%]?8'>U% ` \$('@*%
=5@* ,('8'>U%<6,%RQD'U\$, *((*%!, *@*>('6>%!#+;':%9*,@':*%=>6#>: *A*>(8%M!9=8NL%
R<<*: (8%6<%F'8:;68#, *%H-B*0% !#+;':\$('6>%H-B*%\$>5% b,U\$>'n\$('6>%H-B*%6>%
D6>8#A*,8j%=(('5*8%(67\$,58%RQD'U\$, *((80%W>(*>('6>8%(6%#8*%RQD'U\$, *((8%\$>5%
9*;<Q

! "#\$%&'(\$ %

! "#\$%&'(\$%12%
% %

) *+,#\$, -% . / 0%1213

=F!Y%)\$:#;(-%9*\$,: "%D6AA'((*%M?Z=%Z,\$5-%D6;;*U*N%M12..N%

&

! "#\$%&'(\$%1. %
% %

) *+,#\$, -% . / 0%1213

Y* @' * 7 * , 0% [6# , >\$; % 6 < % 4 \$, \ * (' > U % D6 A A # > ' : \$ (' 6 > 8 % M 12 . P % X % ! , * 8 * > (N %

Y* @' * 7 * , 0% D6 A A # > ' : \$ (' 6 > % Y * 8 * \$, : " % Y * B 6 , (8 % M 12 . P % X % ! , * 8 * > (N %

Y* @' * 7 * , 0% H * ; * A \$ (' : 8 % \$ > 5 % W > < 6 , A \$ (' : 8 % M 12 . P % X % ! , * 8 * > (N %

Y* @' * 7 * , 0% D6 A A # > ' : \$ (' 6 > % k # \$, (* , ; - % M 12 . P % X % ! , * 8 * > (N %

Y* @' * 7 * , 0% [6# , >\$; % 6 < % D " ' ; 5 , * > % t % 4 * 5 ' \$ % M 12 . P % X % ! , * 8 * > (N %

Y* @' * 7 * , 0% [6# , >\$; % 6 < % D # , , * > (% W 8 8 # * 8 % t % Y * 8 * \$, : " % ' > % = 5 @ * , (' 8 ' > U % M 12 . P % X % ! , * 8 * > (N %

Y* @' * 7 * , 0% W > (* , > \$ (' 6 > \$; % [6# , >\$; % 6 < % 9 (, \$ (* U ' : % D6 A A # > ' : \$ (' 6 > % M 12 . P % X % ! , * 8 * > (N %

! "#\$%&'(\$%11%

) *+,#\$, -% . / 0%1213

% %

=A *,':\$>%=:\$5* A-%6<%=5@* ,('8'>U%M===NO% 4 * A+*,8 " 'B%D6AA'((* * 0% 4 * A+*,%
M12.0%X%12. /N%

W>(* ,>\$('6>\$;%D6AA#>':\$('6>%=886:\$('6>%MWD=NO% a * \$;(" %D6AA#>':\$('6>%F'@'8'6>%
4 * >(6,8 " 'B! ,6U,\$A0% 4 * >(6,%M12.0%X% ! , * 8*>(N%

Z * 6,U'\$%a * \$;(" :\$, * %) 6#>5\$('6>0%R@\$;#\$('6>%Y * 86# , : * %D * >(* ,%MRYDNO%Z,\$>(%
Y * @' * 7 * ,%\$>5% ! ,6U,\$A%R@\$;#\$(6,%M12.E%Q%1211N%

D6>86,('#A%<6,Z;6+\$;% 4 * 5'\$D#;(#, * %\$>5%D6AA#>':\$('6>0% 4 * A+*,%M12.E%Q%1211N%
? 9D%=>> * >+*,U%D6AA#>':\$('6>%Z,\$5#\$(* % 9(#5 * >(%=886:\$('6>0% 4 * A+*,%M1220%X%
12. .N%

? 9D% ` 6,A\$>%H6BB'>U%D6AA#>'(-b#(, * \$: "%=886:\$('6>0% 4 * A+*,%M1220%X%12. .N%
%

?>'@*,8'(-%6<Z * 6,U'\$0%D\$, **,%D * >(* ,%MD6>(' +#('6>%(6%D\$, **,%F * @ * ;6BA * >(%6<

? Z=%9(#5 * >(8N%M=7\$,5 * 5%<6,%12.30%12.KO%12.00%12.JO%12.P%\$>5%1212N%

?>'@*,8'(-%6<Z * 6,U'\$0%=;B"\$%b A': ,6>! '0%CSA+5\$%9'UA\$%D"\$B(* ,%MD * ,('<':\$(*%6<
=BB, * :\$('6>N%M=7\$,5 * 5%<6,%121. .N%

?>'@*,8'(-%6<Z * 6,U'\$0%=F!Y%F * B\$,(A * >(\$;%H * \$: " * ,%6<(" * % _ * \$,%12.E%M ` 6A'> * * N%
%

! "#\$%&'(\$%1E%
% %

) *+,#\$, -% . / 0%1213

[Y 4 D%P2K2%M ` \$ "%Y\$- %a\$>NO%9B,'>U%12.P%
[Y 4 D%P2K2%MD\$,6;'> *%d6B6(NO%)\$;,%12.J%
[Y 4 D%J112%M 4\$((" * 7%!'A *>(\$NO%9#AA *,%12.K%
[Y 4 D%P2K2%M_ \$>%9 "\$>NO%)\$;,%12.E%
[Y 4 D%P2K2%M [#>U%a 7\$>% !\$, \ NO%9B,'>U%12.E%
[Y 4 D%J112%MD", '8('> *%Y6+ *, (8NO%9#AA *,%12.1%
[Y 4 D%P2K2%MR#>%966\%d 76>NO%)\$;,%12.1%
[Y 4 D%P2K2%M d#\$>Q

! "#\$%&'(\$%13%

) *+,#\$, -% . / 0%1213

% %

[Y 4 DP . E2L%F'U'(\$;%\$>5%96: '\$;% 4 *5'\$%=5@* ,('8'>U%D6A A#>':\$('6>%9(\$(*U'*8% M9B,'>U%12.30%9B,'>U%12.K0%9B,'>U%12.ON%

=F ! YKJ02L%F'U'(\$;%\$>5%96: '\$;%D6A A#>':\$('6>%9(\$(*U'*8%M)\$;,%12.E0%9B,'>U% 12.30%)\$;,%12.3%\$>5%)\$;,%12.K0%9B,'>U%12.00%)\$;,%12.00%9B,'>U%12.J0%)\$;,%12.J0% 9#A A * ,%12.P0%)\$;,%12.P0%9B,'>U%12./0%9#A A * ,%12./0%)\$;,%12./0%9B,'>U%12120%)\$;,%12120%9B,'>U%121.0%)\$;,%121.0%9B,'>U%1211N%

=F ! YKJ.2L%=5@* ,('8'>U%\$>5%D6A A#>':\$('6>%4\$>U*A *>(%M9B,'>U%12.10%)\$;,% 12.10%9B,'>U%12.E0%)\$;,%12.E0%)\$;,%12.30%)\$;,%12.K0%)\$;,%12.00%9B,'>U%12.J0%)\$;,% 12.J0%9B,'>U%12.P0%)\$;,%12.P0%9B,'>U%12./0%)\$;,%12./0%9B,'>U%12120%9B,'>U%121.0% 9B,'>U%1211N%

=F ! YK//2L%F'U'(\$;%=5@* ,('8'>U%M)\$;,%12..0%)\$;,%12.1N%

)_b9%.22.L%96: '\$;% 4 *5'\$0%=5@* ,('8'>U%\$>5%V,\$>5'>U%M)\$;,%12.P0%9B,'>U%12./0%)\$;,%12./N%

)_b9%.22.L%a67%(6%4\$,\ *(\$%V,\$>5%#8'>U%96: '\$;% 4 *5'\$%M)\$;,%12120%)\$;,%121.N% %

Db 4 4 E1 . L%D6A A#>':\$('6>%>%(" *%&' ,(#\$;%Z,6#B%M9B,'>U%12. . N%MM>8(,#:(6,%6<% Y* :6,5N%

Db 4 4 E12L%9A\$;,%Z,6#B%\$>5%H*\$A%D6A A#>':\$('6>%M)\$;,%12.2N%MM>8(,#:(6,%6<% Y* :6,5N%

Db 4 4 121L%W>,(6%(6%D6A A#>':\$('6>%H* : ">6;6U-%M)\$;,%122/N%MH=N%

Db 4 4 122L%D6A A#>':\$('6>%\$8%\$%96: '\$;%9:'*>: *%M)\$;,%122PN%MH=N%

Db 4 4 E2 . CL%RAB',':\$;%Y*8*\$, : "%'>%D6A A#>':\$('6>%M9B,'>U%122PN%MH=N%

Db 4 4 EPEL%9B6,(80%D6A A#>':\$('6>%\$>5%D#,(#,*%M)\$;,%122JN%MH=N%

Db 4 4 E/OL%)\$8"'6>0%D6A A#>':\$('6>%\$>5%D#,(#,*%M9B,'>U%122JN%MH=N%

Db 4 4 E22L%)6#>5\$('6>8%<6,%9(#5-%6<%R>(*,(\$>A *>(0%D6A A#>':\$('6>%\$>5%96: '*(-% M)\$;,%122ON%MH=N%