```
! "#$%&&#"'(! "#$%&&)#*+,(- ").)*/'(O%1+". 2%*.(#$(3*/,)&4(
          5$$),)+.%'(5"2&."#*/(6*.%"+7.)8%(9%:)+(;.<:)%&(
          27=\%4+>2)+2)#4?\%:<(
          !"#$\&\#'()\%'*+*,(
          egin{align} eg
"#$%&'()*!
          ! "#$#% &' ()*+", -. / O. +*1*. ' '\2' 3\%4" 51. 6*78\%P' *: 56+*1; \% <\( \leftilde \) 2++27" >+511+,?/" 56+18\( \leftilde \) AAB\( \leftilde \)
                           $*++56121*. 'C% "#%"&' ($) "*! $' #+, - "*'. /*O. #$. "*1+22-. $3' ($+. *43&+55*! $66"&". 3"5%
          =#?#!!!! &' ()*+"8%9' *: 56+*1; % <%D; . /*' (8\@AAA\%)
          E#?#\\\ &' ()*+"\\F2)5\\P' *: 56+*1; \\GHH@\\
+&%$,'-!. //)(*'O1*'2!
          =*2/*%9' *: 56+*1; 8% 6. <5++. 60% ()*+"%$50261/5' 1% %?<<*)*2158%/56(*' (%J57'' .). (; %' %E>+*' 5++% %$5+*(' 8%
          @AGK,%065+5' 1%
          =*2/*%9' *: 56+*1; 8%4. (56%2' 3%1. ; 75%M#NN. O5% 6. <5++. 6% <%D6*1*' (8%PAGP,@AGK8%)' 156*/%200. *' 1/5' 1%PAG@,
          =*2/*%9' *: 56+*1; 8%++. 7*215% 6. <5++. 68%' ()*+"%1 %?<<*)*215%27>)1; 8%' 156271*: 5%=53*2%1>3*5+8%AGA,%PAGK%
          =*2/*%9' *: 56+*1; 8%++*+12' 1¼ 6. <5++. 68%' ()*+"% %<<*)*215%27>)1; 8%' 156271*: 5%=53*2%1>3*5+8%AAB,@AGA%
          T655' %4*: 56%N*("%57"...)%M2' (>2(5%?61+%J527"56%GHHP,GHHK%%5>//56+%GHHK,@AAA%
3$4,(%&'() *2!!
 -../0112!%3.4&#'
          =7U558%N5*3*%?#%2' 3%2/5+%&#% . 61567*8&+6"55$+. '#*1+22-. $3' ($+. *' . /*9"(: +&; *<. ("&' 3($+. =*4*>?"(+&$3' #*
                           '. /*@(?$3' #*4AA&+ '3?#%/5O%F. 6WC%4. >1)53(58%/AGX#%
          =7U558%N5*3*%?#%2'3%\2/5+%&#%: 61567*B?''*@(?$35*+6*<. ("&. "(*>"5"' &3?=*4*>?"(+&$3' #\*1' 5")%'5"/*
                           4AA&+'3?7*V5O%F.6WC%I5156%M2'(8%PAAH#*
 -../056#7\&#'8.9\&\\7.:0'
          =7U558%N5*3*%?#8%2'3%$Y'*5))5%*7.)5%$5Z.++8%53+#%{$,$('#E&$($., *455''552''.(*'./*@)'#-'($+.#%-./0>156+%
                          2' 3%-. / O. +*1*. ' '%* (*12)% 65++[912'' %1215%9' *: 56+*1; % 65++$\@AG\#%' 110([[773*(*12)065++#. 6([3O25%
                          &3*1. 6+]%065<2750%'1100[[773*(*12)065++#. 6([3O25[*' 16. #"1/)%
          %
          $5Z. ++8%$Y' *5))5%/*7. )58%N5*3*%?#%=7U558%2' 3%/4*7" 263%5)<58%53+#%
```

```
?@%%A)%4!('&!3$4!&%O&#$)%4!#$!!'#$%&'%()*"+")*")$% &- +&#.$.&)%/)*%D1"$&2.3%&52)/6#%7897!
B3&*'&!B8%22C!+, DE⇒!

=7U558ND5"3"%~#82' 3%.2/5+%&#% .6156#\dM5(2)%2' 3%45(>)21. 6; %++>5+%. 6%J57"'*72)%. //>'*721. 6+%
-.'3>71"'(%T). c2)%1'156' 51%45+5267"#e%B"3?. $3' #1+22-. $3' ($+. %BX%@AGAaC%eK@,@HH#!

$>/*18%*67268%4. '%R51_568%*/%121156+. '8%2' 3%N5*3*%?#%=7U55#\d?'%?++5++/5' 1%. $%)5716. '*7%1. 61<. )*. +%
?76. ++%1"5%->66*7>)>/#e%Q+-&. '#+. '@V3"##". 3"'$. *1+##", "'B"' 3?$. , %@A#G%@AAHaC%G@G,GPK#%

#
=7U558ND5"3"%?#8%2' 3%.2/5+%&#%. 6156#\d!)2; *" (%2%T...3%T2/5C%A1"*72)%++>5+%. 6%==i T%2' 3%Z*61>2)%D. 6)3%
45+5267"56+#e%. ("&. '($+. '#O+-&. '#++6*<. ("&. "(*>"5"" &3?*@(?$35*@#G%@AAHaC%
_"110C[[*h*65#' 51[*++>5] @#G[/7W55#O3<#%

#
=7U558ND5"3"%?#8%2' 3%.2/5+%&#%. 6156#\dJ"5%\d1"*7+% <%$*(*12)%D6*1*' (%45+5267"C%?%4"51. 6*72)%?O06. 27"#e%
1+#", "*1+2A+5$($+. *'. /*1+22-. $3' ($+. *BH%@AAKaC%XGG,XPH#%

%
=7U558ND5"3"%?#8641"*72)%2' 3%M5(2)%++>5+%. 6%D6*1*' (%45+5267"56+%"%2' %?(5% <%=53*2%-.':56(5' 75#e%
1+2A-("&5"'. /*1+2A+5$($+. *@B%@AAKaC%GAP,G@@##"?F*#2!#221%!' (!, &-+5$"2#%/) *% &-+&#.$.&)%
```

: '\$!) \*%!G<%\$!H'<4!9: 3&4!('&!/'2)!2#6\$#(#A3\$)!2A\*'<3&<|!3&)#A3&312631(fs))-1('&)-1(#)-1;1())-1(#)-1(: '\$!)-2())-

"110+C[[O27#7.].+1215#53>[650.+\*1.6;[7.])571\*.'+[15f1(5'53[06.<5++\*.'2],O6\*1\*'([06.<5++\*.'2],O6\*1\*'(.<.6,"52)1"7265[%]

=7U558%N5\*3\*%?#%2' 3% . 61568%2/5+%&#%d0' 15615f1C%D6\*1\*' (%=27''\*' 5+%2' 3%4''51. 6\*7#e%E &\$(\$. , \*I - (-&''5=\* 1+##' %+&' (\$)''C\*4#, +&\$(?2\$3C\*4-(+. +2+-58%53\*153%c; %?' ' %N\*))%\$>\*' %2' 3%4+2c5)% 5356+5' 8%506\*' (568% eA@GC%PX,B@#%

=7U558%N5\*3\*%?#%dE5)\*5:5%' %F. >6+5)<%2' 3%F. >6%?c\*)\*1; %l. %L. \*' %l >c)\*7%2' 3%57''.)26); %-. ':56+21\*. '+#e%

@VA#'. '(\$+. \*8+\$. (5=\*8-%#\$5?\$., \*\$. \*>?''(+&\$3\*'. /\*-. /0. +\*1\*. '8%53\*153%c; %L. ''' %4#%T2))2(''56%2' 3%
\$2' \*5))5%/\*7.)5%\$5Z. ++8%912''%\$1215%9' \*:56+\*1; %l 65++8%@AGH(%O0#%PG,PP#%

 $= 7U558\%N5^*3^*\%?\#\%0' 1567>)1>62)\%-. //>'*721^*.' \%' 3\%J52/O.6WC\%45:*+*' (\%E>+*' 5++\%D6*1*' (\%.6\%T). c2)\% \\ V51O.6W+\#e\%8?''^*<. (''&.' (\$+.'+\%Y' (\$+.*+6*Z7F7^*E&\$(\$.,**8\&+,&' 258\%53^*153\%C; \%6O*' \%D5*+56%2' 3%5''*6)5;% \\ 4.+58\%912''\%1215\%9'^*:56+*1; \%.65++8\@AGKC\MO0#\GKB,$ 

```
%
= 70558\% N5^*3^*\%? \#8\%2' \ 3\%.2 \angle 5 + \%.4\%! \ . \ 61564\% d45 + 5267''*! \ (\%?''(+\&\$3'\%'')^*) \ 50\% R5 \angle *' * + 1\%45 + 5267''\%! \ 6271^*75 + \%' \%! \ (\%?''(+\&\$3'\%'')^*) \ 50\% R5 \angle *' * + 1\%45 + 5267''\%! \ 6271^*75 + \%' \%! \ (\%?''(+\&\$3'\%'')^*) \ 50\% R5 \angle *' * + 1\%45 + 5267''\%! \ 6271^*75 + \%' \%! \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\$3'\%'')^*) \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%)'') \ (\%?''(+\&\%
                         -; c56+0275#e%>?''(+&$3' *$. *H+($+.7%&3+#%&*)55' %57"5))%2' 3%U5)); %42O+. '#%! *11+c>6("C%9' *: 56+*1; % <%
                         !*11+c>6("%!65++8%@AGA#%GB@,GX@#%
=7U558%N5*3*%?#8%2' 3%$Y' *5))5%J*7. )5%$5Z. ++#%l' 16. 3>71*. '#%l $, $('#*E&$($., *>"5"' &3?=*B"3?. +#+, $"'50*
                         H''(?+/+#+,$''56*'./*@(?$3'#*\55-''5#%-65++W*))($N2/01.' %165++8\@AAX#\G,@P#%
&3O263+8%=*7"25)%&#8%2'3%N5*3*%?#%=7U55#%dJ"5%J527"*'(%2'3\M526'*'(% &\D5c\T5'65+%'\R*6+1,F526\)
                         -. /O. +*1*. '#e%T5' 65%?76. ++%1"5%->66*7>)>/#%&3+#%?' '5%N566*' (1. '%2' 3%-"26)5+%= . 62' #MI. (2' C%
                         912"%$1215%1 65++8%PAAB#%GHb,@GK#%
E. 4&F. 4#'
=7U558%N5*3*%?#8%2' 3%L2/5+%&#%1 .6156#)R. 65O. 63#%1' \R. 65O. 63%. 6\%' ' \n\"))\%$>*' \%2' 3\%+2c5)\% 5356+5' 8\%
                         ?>(/5'121*.'%157"'.). (*5+%2'3%?61*<*7*2)%1'15))*(5'75%'%157"'*72)%-.//>'*721*.'(%$5+*('*'(%
                        &1''*72)%R>1>65#%4.>1)53(5#%PA@\#%F*f,ff*%
6#7%. 47$9'G. 4/'
= 7055\%N5*3*\%?#%2' 3\%$Y' *5))5\%*7.)5\%$5Z. ++#%d$*(*12)%0\D6*1*' (\p0\H5+5267''\C%?' \ng2' 156: *50\O^*1''\N5*3*\Kappa 156.)
                          =7U55%2' 3%$Y' *5))5%*7.)5%$5Z.++#e%1+2A-("&5*'./*1+2A+5$($+.*O.#$."'7*@AAXa%
                         "1100[[OOO#c(+>#53>[77. ')*' 5[*' 156: *5O#%
```

 $=70558\%15^3*8\%2' 3\%$Y' *5))5\%^7.)5\%$5Z. ++#\dM51156\%6. \( /\gamma'' 5\mathred{T} > 5+1\%3^*1. 6+\#e\%1 + 2A-(''\&5^*' . \/*1 + 2A + 5\$(\$+. C^*)$ 

d&1''\*7+%.6%?0%D6\*1\*'(C%J''5%L/O.612'75%<%4''51.6\*72)%-.'15f1#e%L2O56%D65+5'121\*.'%D\*1''%L2/5+%L.6156#%

```
d?61*<7*2)%(15))*(5' 75%;(5' 1+%2+% 6. <5++*. ' 2)%-. //>' *721. 6+#e%-. / 0>156+%2' 3%D6*1*' (#%*' 3)2; 8% ''*. #%
        L>' 5%AGX#%
d-.'+>)1*'(%0*1''%-.))2c.621*:5%D6*1*'(%J52/+#e%l'156'21*.'2)%D6*1*'(%-5'156+%++.7*21*.'%-.'<565'75#%
        R>))%02' 5)%065+5' 121". ' %0*1"%U21")55' %-. <<5; 8%E6*3 (51%T5)/+8%2' 3%-; ' 1"*2%L. "' +. ' #%$5' : 568%
        -.). 623. #%i 71. c56% AGb#%
?006. 27''#e%l' 156' 21*. ' 2)%D6*1*' (%?76. ++%1''5%->66*7>)>/%-. ' <565' 75#%?' ' %?6c. 68%=*7''*(2' #%L>' 5%
        @AGb#%
dV2:*(21*' (%2' %1' 3505' 35' 1%D6*1*' (%$5(655%' %2%$50261/5' 1% <%2' ()*+"#e%-.' <565' 75% ' %-.))5(5%
        -. /0. +*1*. ' %2' 3%-. / />' *721*. ' #\n. >+1. ' 8\J5f2+#\?\?06*)\@AGb#\%
dD6*1*' (%-5' 156+%2+%? (5' 1+%. 6%-"2' (50%9+*' (%)' 765 / 5' 12)8%|' 1567. ' ' 57153%|45+5267''%. 6\(M\)26(5,S72)5\(\)
        J62' +<. 6/21*. ' +#e%!' 156' 21*. ' 2)%D6*1*' (%-5' 156+%?++. 7*21*. ' %-. ' <565' 75#% *11+c>6("8%
        !5' '+;):2' *2#%i 71. c56%eAGB#%
d9' *' 15' 353%.))2c. 621*. '+(%-. '+*35621*. '+%. 6445+5267"56+%' 22' 22' (5% <%-. 60. 6215%>6: 5*))2' 75#e%
        -.'<565'75%'%-.))5(5%-./0.+*1*.'%2'3%-.//>'*721*.'#%J2/02%E2;8%R).6*32#%=267''%PAGB#%
d! 261' 56" (%76. ++%->)1>65+(%516215(*5+%. 6%D6*1*' (%-5' 156+%. %>00. 61%! 1567>)1>62)%J52/% 6. h571+#e%>))%
        02'5)%065+5'121*.'%0*1''%$>+1*'%&3O263+8%45'52%R65;8%L.'21''2'%4;)2'3568%2'3%L2/5+%&#%L.6156#%
        0' 156' 21". ' 2)%D6*1*' (%-5' 156%?++. 7*21". ' %-. ' <565' 75#% 6)2' 3.8%). 6*32#% 71. c56%@AGP#%
dJ"5%1261,>0%Z*5OC%= . :*' (%2%16. (62/%1')*' 5#e%PAGP%?'' >2)%-.'<565'75%.6%1"5%-.>'7*)%.6%16. (62/+%'%
        J57"' *72)%' 3%7*5' 1*<*7%-. / / >' *721*. ' #%-.). 623. %06*' (+8%-.). 623. #%5015/c56@AGP#%
%d0' 1567>)1>62)%-. / />' *721*. ' %2' 3%J52/%! 6. h571+C%-. ' +*35621*. ' +%1. %N5)0%D6*1*' (%-5' 156+%R27*)*1215%
```

%

%dJ''5%&1''\*7+% <%' 156' 51%

dJ"5%' 156' 511%]: 5%' 5263%%). 1%2c. >1%1%c>1% 5: 56%+55' %1eC%45+5267''\*' (%55' \*. 6%-\*1\*\_5' +]%J62' +\*1\*. ' +%6. /% ! 6\*' 1,c2+53%!. %D5c,c2+53%!\*15627\*5+#%?++. 7\*21\*. ' % <%! 156' 51%45+5267''56+8%-. ' <565' 75%b#A#% - "\*72(.8%))\*' . \*+#% 71. c56%=AAB#%

## . #O(\*(2'8&'(61!. //)(\*'O1\*'2!

- 8. 1H74&)%. 4I'D4. B&007. : \$9'G47%: @I'\*+\*, 1"4&0&: %'
  - -. ))2c. 621\*' (%O\*1''%7. ))52(>5+% '%6576>\*1/5' 1%. 68%2++5++/5' 1% <8%2' 3%65: \*+\*. ' +% <%1''5%! 6. <5++\*. ' 2)% D6\*1\*' (%/2h. 6%2' 3%1''5%4''51. 6\*7%2' 3%D6\*1\*' (%/\*' . 6\*

H74&)%. 4'. B'%3&'J. F&'G47%: @'?: 7%\$%K&'LJG?M'7: '%3&'E\$4N&4'0)3. . 9'. B'-! 07: &001'\*+P01\*+PRI'?: %&47N' \*+P\*1\*+P0''

- J"5%N D0%'. O%5' 2 / 53%1"5%N ED %2' 3%5). 72153%1. %C5%O\*1"\*' %1"5%N D&a%O2+%1"5%5026215%O6\*1\*' (% 75' 156%2' 3%1"5%O6\*1\*' (,276. ++,1"5,7>66\*7>)> / %D6. (62 / %. 6%1"5%R26 / 56%57"...)% <%E>+\*' 5++%RSEa#%J"5% / \*++\*. '% <%1"5%N D0%O2+%1. %>00. 61%RSE%1>35' 1+%2' 3%27>)1; %O\*1"%1"5\*6%O6\*1\*' (% 553+%. %2+%1. % O6. / . 15%O6. <5++\*. '2)%2' 3%27235 / \*7%>775++%2' 3%1. %0650265%2))%RSE%(623>215+%1. %C5%5f75))5' 1%O6\*156+#%
- 0' %/; %.)5%2+%\*6571. 68%7.))2c. 62153%2' 3%7.,3\*657153%527''% 526%0\*1''%1''655%(623>215%2++\*+12' 1% 3\*6571. 6+% -2\*1)\*' %= 261\*' 8%= 2' 3; % )5h' \*W8%F5c\*' (%q''2. 8%-; ' 1''\*2%L. ''' +. ' 8%4; 2' %Z\*' (>/ 8%J21'')55' % -. <<5; 8%45' 52%R65; 8%E6\*3 (51%T5)/+8%?/\*6%N2++2' 8%J5: \*' %4>1''56<. 638%L. ' 21''2' %4;)2' 356a#%J. (51''56%1''5% ND0%23/\*' \*+1621\*: 5%152/%' %\*f% 526+%3\*3%1''5%.)). O\*' (C\*
  - -.))2c. 62153%O\*1"%RSE%27>)1; 8%12<<8%2' 3%23/\*' \*+1621. 6+%1. %c>\*)3%2' 3% <<56%06. (62//\*' (\*</li>
  - o R27\*)\*12153%PANO.6W+".0+%.6%27>)1;%2'3%+12<<\*
  - o R27\*)\*12153%\GP%O. 6W+". O+%. 6%1>35' 1+%\*', %2' 3% >1,. <,7)2++a\*

  - o \$5:5). 053½' 3½5+\*(' 53

## ?1&%<(\*@!

[4\$#! \$%&'LQ1)4&#7%'!:9&00':. %&#M'

- &' ()\*+''%\BC%45+5267''%= 51'' . 3+% S06\*' (%AGAu%S06\*' (%AG@u%S06\*' (%AGK8%S06\*' (%A@A8%S06\*' (%A@&8%R2))% @A@\a%
- &' ()\*+"%XXAC%D6\*1\*' (% 6. (62/%?3/\*'\*+1621\*. '%R2))%PAGPa%
- &' ()\*+"'%\\PC%D6\*1\*' (%2' 3%D6\*1\*' (%51>3\*5+%' %2%\$\*(\*12)%?(5%S06\*' (%AAbu%R2))%AAXa%
- &' ()\*+"%DAAC%-. / 0>156+%2' 3%D6\*1\*' (% 6271\*7>/%@,7653\*1a%S06\*' (%AAXa%
- &' ()\*+"'[0' 156271\*: 5%=  $53*2\%1>3*5+\%BAX(\%0' 156271*: 5\%E>+*' 5++%- . //>' *721*. ' 8% ' )*' 5% \, 7653*1\%2+\%0261\% <\% BAX$

- $V*7W*\$52: *+, -6. +C; \% = ?\%1>35' 188\&VT\%0XX\%J"5\%..)*1*7+\% < \%D6*1*' (\%.)275/5' 1\% P\%653*1+88\%06*' ( \%AGP\%57..>1 \%.))2/%>' 356 (623>215a8\%VT\PXXC\D6*1*' (\%-.//>'*1; C\%-62<1*' (\%->c)*7\%45065+5' 121*..' +\%-< \%-6. (62/+\%-2)*653*1+88\%06*' ( \%-AGX\%-62\)$
- \$7. >1%))2/%>' 356(623>215a8%VT%PXXC%D6\*1\*' (%. 6% 6. (62/% 6. / . 1\*. ' %2' 3% >c)\*7\*1; %@%653\*1+a8%R2))% @AGb%
- -2\*1)\*' ‰=261\*'

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, 1/.2%
         S. >/; 2\(\)6': 53'8\(623 > 2153\(\$575 / c56\(\)\(\$A\(\)\(\)0\)1'5\(\)' 3*2' \(\$$*2+0.62\(\)\(45aE > *)3*' (\(\)035' 1*1*5+\(\)2' 3\(\)
                        -. //>' *1*5+%1"6. >("%5. 7*2)%=53*2\%
         &)*h2"%5*//. '+8%(623>2153%>//56%PAGX8%E?"&"*$5*H'*H$, +d*%
         &))5' %-57*)8%(623>2153%(AGB8%(AA&+' 3?''5*6+&*1+#' %+&' ($+. =*F(-/''. (*8''&3''A($+. 5*+. *E &$($. , *B+, ''(?''&%
         V*7W*%$2: *+, -6. +c; 8%(623>2153%@AGB8%B?''*8+#$($35*+6*8#' 3"2". (=*4. *@V' 2$. ' ($+. *+6*F(-/". (C*1' 3-#(GC*' . /*
                        4/2$. $5(&' (+&*8"&5A"3($)"5*+6*8#' 3"2". (%
        L. '21"2' %4;)2' 3568%(623>2153%AGG8%45,?61*7>)21*' (%"5%=*++*. '% <%1"5%D6*1*' (%-5' 1560%=2\\)" (\%4.../\%.6\%
                       MTEJt% 56+0571*: 5+%
         U5: *' %4>1"56<. 638%(623>2153%)AGA8%()2; *' ([D6*1*' (%-. ' '571*' (%Z*35. %T2/5+8M526' *' (8%2' 3%
                        -. \( \) 0. +*1*. ' \( \)
         ?+")5; %D21+. ' 8%(623>2153% AGA8% f0). 6*' (%56: *75%' %-2/0>+% 6(2' *_21*. ' +6%? %= . 35)%. 6%56: *75,
                       M526' *' (%' %R*6+1,F526%- . / O. +*1*. ' %
         ! "*))%)5f2' 356%(623>2153%AAX8%J-(*(?' (_5*9+(*E&$($. , =*B?''*W$("&' 3$"56*1+22-. $3' ($+. *' . /*1+2A+5$. , *
                       8&' 3($3"5*+6*-*1; % <\n56. 5+*X' 2"&5*
         : "- : "2%
         U215%?)15';8%1"5+*+%'%06.75++%
         -)2*65\%=51_{(568\%)}"5+*+%" \%06.75++%
         L2f%U*' ' *c>6("8%(623>2153%PAGH8%")"#A$., *(?"*^-&(=*4*M] -""&N*H$V"/DH"(?+/5*F(-/G*+6*! $5A+5$($+.5*'./*
                        433-2-#' ($) "*466"3(%
         ?' *12M. ' (8%(623>2153;@AGH8;\R5/*' *+1;\S1. 6; 15))*' (%| %4"51. 6*72);\N5(. 1*21*. ' +0;\N'5;\R67056*5' 75+% <%
                        = .1''56+\%''26*' (\%''5*6\%E*61''\%51.6*5+\%'')*'5\%
         = 26; 2' 2%E. 215' 65*1568%(623>2153%pAGH8%)! $/*G+-*&''' /*(?''*5G##' %-5dc*B: $((''&*! $/=*8-%#$3*FG##' %$'' . /*
                        43($)$5(*E&$($.,*8"/',+,G**
         =5(2' %57". 511)568%(623>2153%PAGK8%D6*156); %5)<, &<<*727*5+%2' 3%5*+0. +*1*. ' %162' +<560%*6+1, F526%
                        -. / 0. +*1*. ' %1. %D6*1*' (%' %1"5%$*+7*0)*' 5+%
         -2*1)*1 %= 261*1 8%(623>2153%pAG\8%J527''*1 (%. 6%J62' +<560%45<)571*: 5%5)<,?++5++/5' 1%16215(*5+%' %1' 5\R*6+1,
                       F526%-. / O. +*1*. ' %-)2++6. . / %
         =5)*++2%=2_...)5' *8%(623>2153%eAG@8%! $, $('#"'../*8' A"&D%' 5"/=*B?'"*1+2A#''V*W$("&' 3$"5*+6*1+2A+5$($+..*
                       F(-/". (5*". /*<. 5(\&-3(+\&5**)
         = 2' 3; \% )5h' *W8\%'' 5+*+%' %06.75++%
         4; 2' %Z*' (>/8%623>2153%pAG@8%>"DB?$.;$.,*1+.5-#('.(*8'&($3$A'($+.=*8'&($3$A'(+&G*!"5$,.*H''(?+/5*$.*'.*
                        O. #$. "*1+.5-#('.(*B&'$.$.,*8&+,&'2**
         U266; 'MI' 15)/2'8%(623>2153%PAAH8%F(-/". (5*6+&*F+3$'#*1?'., "=*43($)$5(*W$("&'3G*'./*!$,$('#*H"/$'*
         F2' (1/4.2. 8%(623>2153)@AAH8%\$5-'#$Y''*(?''*Z. (&'.5#'('%#''=*4AA#G$., *\$5-'#*>?''(+&$3*(+*1+2A'&'($)''*
                        >?"(+&$3*
         U6*+15' %= . . 658%(623>2153%AAX8%H-#($2+/' #$(G*' . /*H-#($#$("&' 3$"5=*>"2' AA$. , *(?"*X&' /-' ("*@VA"&$". 3"%
         U5: *' %N.)). 8%(623>2153%PAAb8%&' ()*+"8%-6521*: 5%D6*1*' (8%U5*1"%J>/287"2*6a!
A'<18!D1*')8(*@!
         $56:5% '%''5% 65,N52)1''%'3:*+.6;%-.//*1155877.'3>71*'(%/.7W%'156:*5O+%2'3%06.:*3*'(%553c27W%'%
                        362<1+% <\( 200)^721*. '\( \sigma 2156^2 \))+\( 6\sigma 53^72)8\( 5156^* 26; 8\( 2272 \) 3\( 35' 12)\( 6372 \) 3\( 6272 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 635' 12)\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\( 6372 \) 3\(
                        527"%+06*' (#%PA@G,065+5' 1#!
. E&8#2!&*#!F1%)@*('() *!!
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- J527''\*' (%-. / /5' 321\*. ' %6. /% ''5%-5' 156%. 6% J527''\*' (%6, f75))5' 75% J&a#%55)57153%c2+53% ' %657. / /5' 321\*. ' +% <%(623>21\*' (%5' \*. 6+#%AG@%AG\%AGP#%AGB\%AGB\%AGK\%AGK\%AGK\%AGH\%A@A\%@A@G\%A@%
- &f75))5' 75%' %-26556%\$5:5). 0/5' 1%?O263#%?O26353%c; %=\*2/\*%P' \*: 56+\*1; %1. %57. (' \*\_5%5f5/0)26; % 7. //\*1/5' 1%1. %1''5%35:5). 0/5' 1% <%06. <5++\*. ' 2)% 00. 61>' \*1\*5+%. 6%=\*2/\*%1>35' 1+%2' 3% (623>215+#%5015/c56%PAGP#%
- E5+1%?61\*7)5%457. (' \*1\*. ' #%d! . )\*7; %= 21156+%V. O%2' 3%' %1"5%R>1>650%V51%V5>162)\*1; 8%-. 60. 6215%\$212% = \*' \*' (8%2' 3%T. : 56' / 5' 1%5>6: 5\*))2' 75e%5)57153%l. %c5%506\*' 153%' %J"5(\*+6\*<. /"A". /". (\* 1+2A+5\$(\$+. \*' . /\*>?"(+&\$3\*0+-&. ' #5\*KLTK%l 26). 6% 65++8%PAG\#%
- i >1+12' 3\*' (% 6. <5++. 6% O 263 % 55) 57153 %; % ' 356 (623 > 215 % 1 > 35' 1+ % . 6% ''\* + % 2 / 0 > + % O 263 % (\*: 5' % c; % '' 5% + + . 7\*2153 % 1 > 35' 1 % . : 56' / 5' 1 % 2' 3 % 2 / 0 > + % 71\*: \*1\*5 + % 1. % 06. <5++. 6 + % O'' . % '2: 5 % '' . O' % 5 f 75)) 5' 75 %' % 5 2 7''\*' (% c; % d: 2) > \*' (% ' 356 (623 > 215 % 5 + 526 7'' 8 % + \*' (% ' ' . : 21\*: 5 % 5 2 7'' \*' (% / 51'' . 3 + % 2' 3 % 5' (2 (\*' (% '' 5 % . / / > ' \*1; % '' 6. > ('' % 271\*: 5 % ' : .): 5 / 5' 1 % O \*1'' % 1 > 35' 1 % 6 (2' \* \_ 21\*. ' + # e % 06\*' (% @ A G G # %
- 9#\$#%1 6. <5++. 6% <%1"5%F526%V. /\*' 55#%V. /\*' 2153%C; %1"5%1 6. : . +1%2+%1"5% ' 5%27>)1; %/ 5 / C56%1. % 65065+5' 1%=\*2/\*%' %1"\*+% 21\*. ' 2)%7. / 051\*1\*. ' #%PAGA#%
- ?++\*(' 53%45+5267''%?00. \*' 1/5' 1#%-.))5(5% <%?61+%2' 3%57\*5' 75#%=\*2/\*%9' \*: 56+\*1; #\R2))\@AAKu\\$06\*' (\%@AGb\%
- R\*' 2)\*+1%. 6%"5%AAb%----%0' 2"5\*J"&#\$. \*H"2+&\$'#O-(5(' . /\$. , \*! \$55"&(' (\$+. \*4: ' &/#%=267"%AAb#%
- U'\$&+5\*J"5(\*E"%\*B"V(\*4: '&/%4>' '56,90#%?O26353%21%-. /0>156+%2' 3%D6\*1\*' (#%L>' 5%AAB#%
- \$\*+1\*' (>\*+"53%J527"\*' (%?O263\R\*' 2)\*+1\%' '5% <\%5' \%\*' 2)\*+1+\%. 6\%72\/O>+,O\*35\%2O263\\P\\P\=2++\% ?\/"56+1\P\\\P\\AAP\,\@AAB\\P\\

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## **Grants Awarded (2005-present)**

- -26556%T62' 18%=\*2/\*]+%-5' 156%. 6%-26556%&f0). 621\*. '%' 3%>775++%zGA@X%. %7.:56%5f05' +5+%. % 12W5%T62' 1%D6\*1\*' (%1>35' 1+%1. %45\*); %J. O' +''\*0%l. %/551%O\*1''%7. //>'\*1; %/5/c56+%2' 3%J. O' +''\*0%J6>+155+%2' 3%L. %523%2%7. //>'\*1; % 553+%2++5++/5' 1a#%506\*' (%eA@\#%
- -26556%T62' 18%=\*2/\*]+%-5' 156%. 6%-26556%&f0). 621\*. '%2' 3%>775++%z\A@%1. %7.:56%5f05' +5+%1. % 12W5% 6. <5++\*. '2)%D6\*1\*' (%20+1. '5%1>35' 1+%1. %45\*); %J. O' +''\*0%1. %/551%O\*1''%7. //>'\*1; %/5/c56+%2' 3%J. O' +''\*0%16>+155+a#%\$06\*' (@AGH#%
- \$1>35' 1\(1)57''' . ). (;\(1)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\)R55\(2)\]R55\(2
- \$1>35' 1\(1/357''' \cdot \). (;\(1/37655\)\(1/37655'\)\(1/356\)\(623>215\)\(06355\)\(1/356\)\(623>215\)\(0635\)\(1/356\)\(1/366
- \$1>35' 1\(1)57''' . ). (;\(1)57\);\(2)215\);\(2)215\);\(2)215\);\(2)215\);\(2)215\);\(2)215\);\(2)215\);\(2)2215\);\(2)232\).\(2)242\);\(2)232\)
  \(2)242\);\(2)232\);\(2)242\);\(2)232\)
- d\$\*(\*12)%1.6;15))\*' (%'%1"5%UG@%-)2++6../#e%i ''\*. %N>/2'\*1\*5+%-.>'7\*)#%i '5% <%5:562)%7.,! 0+8%523%! 0%O2+%\$6#%N5)2' 5%?' 36. '5#% zPH8%BHXa#%/.1%>' 353#%
- \$1>35' 1\(2012) 57''' . ). (;\(2018) 7006. f^\*/215);\(2018) 208AAA\(2018. 6\(2018)
- \$1>35' 1\(\)\(57'''\).\).\(;\)\(\R55\)\(\)\(\R55\)\(\)\(\R55\)\(\)\(\R55\)\(\R7)\)\(215\);\(\R2\)\(\R4AA\)\(\R4\)\(\R4A\)\(\R4\)\(\R4A\)\(\R4\)\
- -)2++6.../%\' ''2' 75/5' 1\%-..>' 7\*)\%-)2++6.../\%90(6235#\%D\*1''\%J566;\%L.O5))#\%2006. f#\%z\A\8\A\A\a\%\.\%65'..:215\%''655\%)2++6.../+\%' 1.\%201.O\%)2++6.../+\% 9! N\%GPG\%P\\\%2' 3\%\P\\\a\#\%
- -)2++6.../%2' "2' 75/5' 1%-..>' 7\*)%-)2++6.../%90(6235#%D\*1"%U566; %L.O5))#%2006. f#%zGB8AAA%1.% >0(6235%E?-%eBP%L.%2%)201. 0%7)2++6.../#a%SO6\*' (%eAAH#%

- Q' <. 6/21\*. ' %J57'' . ). (; %S56: \*75+[S1>35' 1%J57'' . ). (; %R55#%D\*1'' %J566; %L. O5))#%2006. f#%z\A8AAA% 2O26353%c; %L6. : . +1%2' 3%J%. 6%6521\*. ' % <%O\*65)5++%201. O%)2++6. . / 8%). 721\*. ' %90'' 2/ %GbXa#%R2))% @AAX#%
- Q' <. 6/21\*. '%157"'.). (; %556: \*75+[S1>35' 1%157"'.). (; %R55#%□\*1"%-; '1"\*2\M5O\*57\W\*, □\*)+. '%2' 3% U5\*1"\%1>/2#%2006. f#\%2\A\A\A\A\Q026353\%c; \%16.:.+1\%2' 3\%1\%. 6\%6521\*. '% <\%0\*65)5++\%201. 0\%7)2++6.. /8\%E27"5). 6\%BA\A\%06" (\%A\A\X\#\)

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F%P); ''8!K%T#%: ! E &\$(\$.,\*1+22+.5\*

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- -?\$\J-! M\\! 6. \/ . 1\\*. \\ / \\*11558\@AGK\\\@A@A\\
  - 45:\*5053%'\*: 56+\*1; %2' 3%7.))5(5%(>\*35)\*' 5+%2' 3%5:\*+53%-?\$%(>\*35)\*' 5+%. 6%06. / . 1\*. '%1. % 1"5% 50%'\*("5+1%2' W%J527''\*' (%16. <5++. 68%5' \*. 6%/571>6568%55' \*. 6%-)\*' \*7\*2' a%
- RSE%?++5++/5' 1%-. //\*11558%\$52' %?00. \*' 1/5' 18/@AG\,@AGK%
  - o 45: \*5053%2++5++/5' 1%0)2' +%. 6%2))%350261/5' 1+%' %RSE%
  - o -.,<27\*)\*12153%2' %2++5++/5' 1% <% 62)%2' 3%O6\*115' %7. //>' \*721\*. ' %' %RSE]+%20+1. ' 5+%
- N-D&%D6\*1\*' (%-5' 156%\$\*6571. 6%5267''%-. //\*11558%PAGX%
- RSE% . 65% >66\*7>)> /% . //\*11558%\$52' %?00. \*' 1/5' 18/@AGP,@AGX%
  - o 45: \*+53\RSE]+\%526' \*' (\%(.2)+\%2' 3\%0)2' ' 53\% 50\%'. 65\%7>)>/\%
- D6\*1\*' (%7".)26+%-.,-..63\*' 21.68%/AGB,@AGX%
  - o -.))2c. 62153%O\*1"%-21"; %D2(' 56% -6521\*: 5%D6\*1\*' (a8%L2 / 5+%J. c\*' %L. >6' 2)\*+ / a8%4\*7"263% -2 / Oc5))%L. >6' 2)\*+ / a8%J. %35: 5). O%2%6. ++,350261 / 5' 1%D6. (62 / %
  - o 4523%' 3%5: \*50%' 356(623>215%200)\*721\*. '+%1. %/2W5%57. //5' 321\*. '+%1. %23/\*++\*. '+%
  - o ! 261\*7\*0215%' %6576>\*1/5' 1%5:5' 1+%2' 3%0)2' %O6\*1\*' (%5:5' 1+%. 6%1>35' 1+%
- Z\*+\*1\*' (% 6. <5++. 6[0' +16>71. 6%5267''%-. / /\*1155%. 6%RSEÆ9S%GA@%27>)1; 8%PAG\8%PAGP8%PAGD8%PAGX%
- -5' 156%. 6%D6\*1\*' (%£f75))5' 75%9' \*: 56+\*1; %?3:\*+. 6; %E. 2638%@AAb,@AGb%
- N. O5%-5' 156%. 6%D6\*1\*' (%6f75))5' 75%\$\*6571. 6%55267''%-. / /\*11558% 6.:. +1%?00. \*' 1/5' 18%PAGB%
- RSE%?++. 7\*215%\$52' %5267''%-. //\*1155%\$52' %?00. \*' 1/5' 16 AGB%
- RSE%M526' \*' (%-. / /\*1155%\$52' ]+%?00. \*' 1/5' 18%PAG\,@AGP%
- -?S%M526' \*' (%RM-8%AG\,@AGP#%

- -"2\*6%5267"%-. //\*1155%/5/c568%/56(\*'(%J57"'.). (;%'%E>+\*'5++%I%\$5+\*('8%-.))5(5% <%-6521\*:5%?61+8%\$52'%?00.\*'1/5'18%PAGH,@A@A%
- \$5267"\%. \/\*1155\%\5\c568\\\$5+\*('\\\2'\3\\\\4. c. 1\\*7+\\\\5'\>65,)\\*'\5\\\5267"\8\\\\AGH\\
- = 211"50%E. 263%J5">65%2"3% 6. /. 1\*. '%-. //\*1155%@AGK%
- \$5267''\(\gamma\). \[ / \*1155\(\gamma\) 5 \[ \c568\(\gamma\)\*61>2)\(\gamma\)52)\(^1; \gamma\)5' \[ >65,)\(^1\) 5\(\gamma\)5267''\(\gamma\)@AGK\(\gamma\)