

# BIOM4951

F YgYufWx 'H\Yg]g'5

HYfa %Z &\$&



7ci fgY`Cj Yfj ]Yk

GHJZ`7cbHJW`8YHJ]`g

7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`]m	@cW]h]cb	D\cbY
A UH\Yk `6fcX]Y	<a href="#">h\Yg]g"V]ca YXYb[ 4 i bgk "YXi "Ui</a>	VmUddc]bha Ybh	GUa i Y`g') %)	
H]Ubf] c ; i c	<a href="#">h[ i c4 i bgk "YXi "Ui</a>	VmUddc]bha Ybh	GUa i Y`g') %)	

GWXcc`7cbHJW`hZcfa Uh]cb

Gh XYbhGYfj ]W]g`W]b`VY`WcbHJW`X]j ]U`i bgk "h# YVZcfa g"

## 7 ci fgY'8YHJ`g

I b]hg'cZ7 fYX]h(

Gi a a UfmicZ\hY'7 ci fgY

H\Y'hYg]g'dfcj ]XYg'Ub'cddcfh b]hmiZcf'mci 'hc'Vf]b[ 'hc[ YhYf'Yb[ ]bYYf]b[ 'df]bW]d'Yg'YUfbYX'cj Yf mci f'dfYj ]ci g'mYUfg'cZgh XmUbX'Udd'mhYgY'df]bW]d'Yg'hc' ]b]bcj Uhj Y'mgc'j Y'dfcV'Ya g'gi V\Ug'hY XYj Y'cda YbhcZU'gdYW]ZWXyg[ bZ'dfcW'gg'UbX#cf'hY ]bj Ygh[ Uh'cb'cZU'\md'chYg]g" H\Yg]g'dfc'YW'g'UfY W'ca d'Yi Z'cdYb!YbXYX'dfcV'Ya g'hUhU'ck 'fcca' Z'cf'mci f'WYU'hj ]mZ'UbX'hY'UW'ei ]g]h'cbZ'UbU'mg]g'UbX ]b]h'fdYU'h]cb'cZ'fYgi 'hg" H\YfY'UfY'a i 'h'd'Y'dcgg]V'Y'gc'i h'cbg'cf'W'cbW] g]cbg'Uh'hY'ci hgYh'UbX'gi Z]W]Ybh W'ca d'Yi ]mhc'fYei ]fY'U'XY[ fY'cZ'dfc'YW'id'Ubb]b[ "H\Y'hYg]g'fYei ]fYg'mci 'hc'Z'fa i 'Uh'Y'dfcV'Ya g' ]b gW]Ybh]Z'W'cf'Yb[ ]bYYf]b[ 'h'fa g'za UbU[ Y'Ub'h'W'cb]W]d'fc'YW'h'UbX'Z]bX'gc'i h'cbg'Vm'Udd'm]b[ 'gW]Ybh]Z]W'UbX Yb[ ]bYYf]b[ 'a Y'h'cXg" M'ci 'k ]'U'gc'XYj Y'cd'mci f'UV']mhc'k cf\_]b'U'fYgYUfW'UbX'XYj Y'cda Ybh Ybj ]f'cba Ybh'M'ci 'a i gh]XYbh]Zm'U'gi dYf] ]gc'f'UbX'dfc'YW'id]cf'hc'Ybfc' ]b[ ]b'h]g'W'ei fgY"

## 7 ci fgY'5]a g

H\Y'hYg]g'dfcj ]XYg'Ub'cddcfh b]hmiZcf'hY'gh XYbh'hc'Vf]b[ 'hc[ YhYf'Yb[ ]bYYf]b[ 'df]bW]d'Yg'YUfbYX'cj Yf hY]f'dfYj ]ci g'mYUfg'cZgh XmUbX'Udd'mhYgY'df]bW]d'Yg'hc' ]b]bcj Uhj Y'mgc'j Y'dfcV'Ya g'gi V\Ug'hY XYj Y'cda YbhcZU'gdYW]ZWXyg[ bZ'dfcW'gg'UbX#cf'hY ]bj Ygh[ Uh'cb'cZU'\md'chYg]g" H\Yg]g'dfc'YW'g'a i gh VY'W'ca d'Yi Z'cdYb!YbXYX'dfcV'Ya g'hUhU'ck 'fcca' Z'cf'gh XYbh'WYU'hj ]mZ'UbX'hY'UW'ei ]g]h'cbZ'UbU'mg]g'UbX ]b]h'fdYU'h]cb'cZ'fYgi 'hg" H\YfY'a i ghVY'a i 'h'd'Y'dcgg]V'Y'gc'i h'cbg'cf'W'cbW] g]cbg'Uh'hY'ci hgYh'UbX'gi Z]W]YbhW'ca d'Yi ]mhc'fYei ]fY'U'XY[ fY'cZ'dfc'YW'id'Ubb]b[ 'Z'ca 'hY'gh XYbh'H\Y'hYg]g'fYei ]fYg'hY gh XYbh'hc'Z'fa i 'Uh'Y'dfcV'Ya g' ]b'Yb[ ]bYYf]b[ 'h'fa g'za UbU[ Y'Ub'Yb[ ]bYYf]b[ 'dfc'YW'h'UbX'Z]bX'gc'i h'cbg'Vm'Udd'm]b[ 'Yb[ ]bYYf]b[ 'a Y'h'cXg" Gh XYbh]U'gc'XYj Y'cd'hY]f'UV']mhc'k cf\_]b'U'fYgYUfW'UbX'XYj Y'cda Ybh Ybj ]f'cba Ybh'

## 7 ci fgY'@YUfb]b[ 'Ci hW'ca Yg

% 8Yj Y'cd'U'XYg][ b'cf'U'dfcW'gg'cf' ]bj Ygh[ Uh'U'\md'chYg]g'Z'ck ]b[ ]bXi ghfm'UbX'dfcZ'gg]cbU' Yb[ ]bYYf]b[ 'gh'UbX'UfXg"  
& 7 f]h]W'`mfYZYW'h'cb'U'gdYW]U' ]ghVcXmcZ\_bck`YX[ Y'fY'Uh'X'hc'hY]f'hYg]g'hc'd]W'  
' " 5dd'mgW]Ybh]Z]W'UbX'Yb[ ]bYYf]b[ 'a Y'h'cXg'hc'gc'j Y'Ub'Yb[ ]bYYf]b[ 'dfcV'Ya "  
( " 5bU'mgY'XU'U'cV'YW]j Y'mi g]b[ 'ei Ub]h]U'h] Y'UbX'a Uh'Ya Uh]W]'a Y'h'cXg"  
) " 8Ya cbgh'U'h'cf'U'UbX'k f]h'Y'b'W'ca a i b]W]h]cb' ]b'dfcZ'gg]cbU'UbX'Um'X'ca U]bg"  
\*" G'c'j Y'V]ca YX]W'dfcV'Ya g'Vm'Udd'm]b[ '7 @C'g'%) "

## HYUW]b[ 'G'h'U'h] [ ]Yg'

H\Y'W'ei fgY' ]g' ]h]i [ \h'Ug'Ub' ]bX]j ]Xi U'fYgYUfW'dfc'YW'z'hc'XYj Y'cd'U'Yj Y'cZ'fYgYUfW'g\_]`g'UbX Ui h'cbca m'

## 5XX]h]cbU'7 ci fgY'`bZ'fa Uh]cb

H\YfY' ]g'bc'cZ]W]U'W'Ugg'h'a Y'Z'f'h]g'W'ei fgY'Z'k \]W'd'U'W'g'U'Z'W'g'cb'g'Y'Z'a ch] Uh'X'Y'Ufb]b[ "M'ci 'a i gh gh'Y'bg'fY'mci f'Ybfc'a Ybh'UbX'fY[ ]g'h'U'h]cb' ]g'i d'hc'X'U'h' ]b'mci f'Ybfc'a Ybh'M'ci 'a i gh\Uj Y'gY'Y'W'h'X'U' d'fc'Y'W'h'VY'Z'fY'k YY\_'\$'cZ'h'fa "'Z'mci '\Uj Yb]h'X'cb'Y'gc'U'fY'U'X'mZ'd'Y'Ug'Y'W'cb'U'W'h'hY'W'ei fgY'W'c'fX]b'U'hc'f" M'ci f'Z]W]h'hc'!Z]W]h'a Y'b'Y'X'g'hc'VY'cf[ Ub]g'Y'X'k ]h' ]mci f'gi dYf] ]gc'f'Z'Ug'mci 'UfY'Yi dY'W'h'X'hc'a Y'h'h'h'Ya 'Uh'Y'Ugh'cb'W'dY'f'k YY\_"

9I dYWUjcbg'cZGhi XYbhg

- E WX\_ af[hSfW ^Sd [ Y
- ? Wwf kagdegbWh[eaddWg'Sdk
- 5 a\_ b WWS ^fZWSeeW\_e\_ W fe a` f[ W
- 3 ffW V fZWI Ww] \$ fgfad[S^a` Ua` VgUf[ Y fWdSfgdWdWh[W e

# 5ggYgga Ybh

5ggYgga YbhUg_	K Y][ \h	8i Y'8UHŸ	7ci fgY'@YUfb]b[ Ci hWca Yg'5ggYggYX
%"· ðhŸf]a 'F Ydcfh	;%\$	A cbXUmK YY_ '%%%%) - 'da	%ž&ž' ž'(ž) ž*

## 5ggYgga Ybh% ðhŸf]a 'F Ydcfh

Gi Va ]gg]cb'bcŸg. 'Mci 'a i ghgi Va ]hU'XfUZhcZmci f'@]hŸfUŸi fY'F Yj ]Yk 'hc'Ga Ufh]b\_]b[ ž'hYb'gi Va ]hmcif  
Ga Ufh]b\_]b[ 'ZYXVUW\_Ÿc'A ccX'Yždf]cf'hc'gi Va ]gg]cb'cZmci f'ðhŸf]a 'F Ydcfh'CbW'Ÿmci 'fYW]j Y'hY  
ga Ufh]b\_]b[ 'ZYXVUW\_žd'YUgY'i d'cUX'h]g'hc'A ccX'YžUbX'hY'gi Va ]gg]cb'hc'k ]'cdYb'žcfmci "  
8i Y'XUHŸ. 'A cbXUmK YY\_ '%%%%) - 'da

ð'hYg]gž'hYfY'UfY'hfY'X]ZYfYbhUggYgga YbhghU[ Yg"

H\Yg]g'5. 'ðhŸf]a 'F Ydcfhf%\$| ŁžGi dYfj ]gcf'7\YW\_]ghfG5# BŁ

H\Yg]g'6. 'Dfc[ fYgg'GYa ]bUf'UbX'F YZYW]cb'f%\$| Ł

H\Yg]g'7. ': ]bU'fYdcfhf\*) ŁžDUfh]W]dU]cb'f) Łž'7cbZYfYbW'DfYgYbU]cb'f%\$| Ł

## Mci f'cV'YW]j Yg]b'H\Yg]g'5'UfY

" Hc'Vi ]X'mci f'\_bck'YX[ Y'VUgY'cb'mci f'gdYW]WfYgYUfW'hc d]W  
&" I gY'hU]\_bck'YX[ Y'VUgY'hc']bžcfa' mci f'gdYW]Wdfc'YW]U]a g'UbX'a YhcXc'c[ m'  
' " 7ca d'YH' dY'ja ]bUfmk cf'\_hc k UfXg'a YH]b[ 'hY'gdYW]Wdfc'YW]U]a g"

Hc'UggYgg'h]gž'hYfY'UfY'hc'c'UggYgga YbhUg\_g'žcf'H\Yg]g'5"P

ðhŸf]a 'fYdcfhf%\$| Ł

" @]hŸfUŸi fY'fYj ]Yk 'cf'Yei ]j U'Ybhf) \$| Ł  
%" K \Uh]g'hY'dfcV'Ya 'hc'VY'gc'j YXž'UbX']hg'g][ b]Z]W]bW]3  
&" A i gh]bW] XY  
%"

% >i ghZVWhcb'cZha Y'U'cWWhcb'Zc'fYUW'fUg\_  
' " 5j U]UV'Y'fYgci fW'g']XYbhZ]YX  
( " F Yei ]fYX'fU]b]b[ 'UbX'i dg\_]`b[ ' ]XYbhZ]YX

% Dfc YVh8YdYbXYbhDfYdUfU]cbg'f&\$i Ł  
% 7 Ub'hY'ghi XYbhUW]Yj Y'hY'U]a g']b'hY'h]a Y`]bY3'K \UhdFc[ fYgg'\Ug'VYYb'a UXY  
U'fYUXmB  
&" Dfc YVhgdYWZ]W'Vi ha Um]bWi XY  
% 9j ]XYbW'cZhfU]b]b[ 'cb'gdYWZ]WYei ]da Ybh  
&" 9j ]XYbW'cZgca Y'i dg\_]`b[ ' ]b'bYk 'gcZk UfY#a YhcXg  
' " DfY'ja ]bUfmfYgi `hg  
( " DfY'ja ]bUfmig\_YhWYg  
) " 7 ca dcbYbhg#dUfYg'cfXYfYX  
\*" 8YhU]YX'Vi X[ YH † %o %o



# F Ygci fWg

## DfYgWf]VYX F Ygci fWg

F Ygci fWg'k ]`VY'a UXY'Uj U]UV'Y'rc` \Y'd'ghi XYbng [ i ]XY'hYa` ]b'hY]f'ci fbYmZcf'H\Yg]g'5"

## 9I hYbg]cbg

Mci`Wb'Udd'mZcf'[gdYWU`Wcbg\]XYfU\]cb`k` \Yb` \]`bYgg'cf'chYf'W\]FW`a`gHUbWg` \]bHfZYf'k` \]h'mci`f` UggYgga`YbhdYfZ'fa`UbW`"](#)

C hYf'Udd`]W]h]cbg`Zcf'YI`hYbg]cb'cZgi`Va` ]gg]cb'cZhYg]g'fYdcfng'fY`["`"Yei` ]da`YbhVfYU`Xck`bZ'YHwL`

```
%`8 ]gW`gg'hY'dcgg]V`] ]micZUb`YI`hYbg]cb`k` ]h'mci`f'gi`dYfj` ]gcf`Z]fgh`
&`F`Yei`Ygh`WUb`h`Yb`VY`cX[`YX`VmihY`ghi`XYbh`YfY`\hdl.##\]bmi`f`Wca`#m&hdnj`"H\Y`gi`dYfj` ]gcf`k` ]`
h`Yb`fYW`j`Y`Ub`Ya`U` ]`Ug_]b[`h`Ya`rc`Uddfc]`YzVYZcf` ]h]g`YgWU`UH`X`rc`h`Y`XYW]g]cb`dUbY`"
'`F`Yei`Ygha`i`ghVY`cX[`YX`VmK`YY`_*`cZhf`a`"
(`D`UbY`XYW]g]cb`k` ]`VY`a`UXY`VmYbX`cZk`YY`_`+"
)`H\Y`XYW]g]cb`k` ]`VY`a`UXY`VmU`dUbY`-`Wcbg]gh]b[`cZhY`<cG`f'f'hY]f'bca` ]bYYLz`H\Yg]g`
7`ccfX]bUrcfz`UbX`%`chYf`dYfgcb`"
*`Gh`XYbng`g\ci`X`VY`U`Y`fY`X`rc`h`Y`ZUWh`h`Uh`h` ]g` ]g`bch[`i`UfUb`hY`Xz`UbX`h`i`g`g\ci`X`bchfY`mcb`
[`Yh]b[`Ub`YI`hYbg]cb`"
+`Hm]WU`nZ`YI`hYbg]cbg`UfY`[`fUb`hY`X`I`D`HC`" `k`YY`g`"H\Y`Yb[`h`cZhY`YI`hYbg]cb`bYYXg`rc`VY`
fYei`Ygh`X`UbX`^`gh]Z`YX`VmihY`gi`dYfj` ]gcf`"D`UbY`k` ]`XYW]XY`h`Y`Yb[`h`cZha`Y`[`fUb`hY`X`"
" `
```

## DfcWXi fY ]Zmci`ZU]`H\Yg]g'5z6`cf'7

: U]` ]b`H\Yg]g'5`f]bHf]a`fYdcfha`Uf\_`O`) \$i` E`-`a`i`ghfY!Ybfc` ]b`H\Yg]g'5`U[`U]b`"

: U]` ]b`H\Yg]g'6`fgYa` ]bUf`a`Uf\_`O`) \$i` E`-`a`i`ghfY!Ybfc` ]b`H\Yg]g'6`U[`U]b`"

: U]` ]b`H\Yg]g'7`-`Gh`XYbng` \Uj`Y`h`fY`cdh]cbg`"

```
%`fY!Ybfc`Zcf`H\Yg]g'5z6`UbX`7`U[`U]bzbYk`dfc`YWh`UbX`gi`dYfj` ]gcf`
&`fY!Ybfc`Zcf`H\Yg]g'7`U[`U]bZgUa`Y`dfc`YWh`bYYXg`WcbgYbhcZUb`Uddfcdf]Uh`gi`dYfj` ]gcf`/`gh`XYbh`
'`Gh`XYbhXcYg`Z`fH`Yf`k`cf`z`fY!gi`Va` ]hg`h`Yg]g`UZh`f`U`a`Ul`cZ`*`k`YY`g`"5`agdeWa`Uf_`WUddYX`Uh`
)`$i`" `zgh`bchgUh]gZUWc`fnz`h`Yb`bYYXg`rc`fY!Ybfc`"
```

H\]g`Ughcdh]cb` ]g`cb`mUj`U]UV`Y` ]ZhY`cf][` ]bU`a`Uf\_`k`Ug` ( `\$CF` ]ZhY`gh`XYbh]g` ]b`hY]f`UghigYa`YghYf` VYzcfY`[`fUXi`Uh]cb`ffY[`UfX`Ygg`cZhY`cf][` ]bU`a`Uf\_`L`"

: U]` ]b`H\Yg]g'6` / `7`fk` \Yb`hU`Yb`g]a`i`hU`bYci`g`nt`-`Gh`XYbng`a`i`ghfY!Ybfc` ]b`H\Yg]g'6`U[`U]bZ`UbX` WUbbchWcbW`ffYbhmYbfc` ]b`7`" `H\YmWUb`h`Yb`hU`Y`H\Yg]g'7`k` \Yb`H\Yg]g'6` \Ug`VYYb`gUh]gZUWc]m` Wca`d`YhX`"

## Xi ghfmH\YgYg

K`Y`YbWci`fU[`Y`gh`XYbng`rc`gYY`\_`dUf`fY`fg` \]dg`k` ]h` ]bXi`ghfmz`gc`gh`XYbng`WUb` \Uj`Y`U`Wc!`gi`dYfj` ]gcf`Zca`



]bXi gfrn' <ck Yj Yfz' ]ZWcbZXYbhU ]hm]g'fYeI ]fYXž'U'WcbZXYbhU'X]gWcgi fY'U[ fYYa Ybhf7 8 5Ł' ]g'cV' ] [ Uhcfrn'

# Gi Va ]gg]cb'cZ5ggYgga YbhiHUg\_g

@UVcfUhcfmfYdcfng'UbX'a U'cf'Ugg][ ba Ybht'k ]''fYei ]fY'U' [Bcb'D'U\[ \]Uf\]ga '8YWUfU\]cb'7cj Yf'G\YYH'](#)

5gg][ ba Ybht'g\ci 'X'VY'gi Va ]H'X'cb'hja Y''5'XU]mdYbU'micZ) i 'cZhY'a Uf\_g'Uj U]'UV'Y'Zcf'hUh  
Ugg][ ba Ybhk ]''Udd'mZcf'k cf\_'fYW'j YX'UZ'Yf'hY'Xi Y'XUH''5bmiUgg][ ba Ybhia cfY'h'Ub') 'XUmj''UH'k ]''bch  
VY'UW'Wdh'X''H\Y'cb'mYI Ya dh]cb'k ]''VY'k \Yb'df]cf'dYfa ]gg]cb'Zcf''UH'gi Va ]gg]cb'\Ug'VYYb'[ fUbh'X'Vm  
hY'7ci fgY'W'cfX]bUhc'f''9I hYbg]cbg'k ]''VY'[ fUbh'X'cb'mcb'a YX]W'cf'W'a dUgg]cbUH'[ fci bXg'i bXYf  
YI hfYa Y'W'fW'a ghUb'W'g''

# 5 WUXYa ]W< cbYgmiUbX`D`U[ ]Uf]ga

D@5; =F ≠GA

6Yk UFY`5b`Ugg][ ba YbhUUh]bW XYG`d`U[ ]Uf]gYX`a UHYf]U`k ]`fYW]j Y`U`\$i : U]žUbX`gh XYbhtg`k \c  
d`U[ ]Uf]gY`a UmZ]`hY`Wti fgY`Gh XYbhtg`k \c`d`U[ ]Uf]gY`k ]`\Uj Y`hY]f`bUa Yg`YbHYfYX`cb`U`d`U[ ]Uf]ga  
fY[ ]ghYf`UbX`k ]`VY`]UV`Y`hc`X]gW]d`]bUfmiUW]cbž]bW X]b[ `YI W] g]cb`Zca `Ybfc`a`Ybh`  
#]g`YI dYWYX`hUUhU`gh XYbhtg`a i ghUUhU`h]a Yg`gi Va ]hY]f`ck`b`k`cf`\_`Zcf`UggYgga Ybh`Gi Va ]h]b[ `hY  
k`cf`\_`cf`]XYUg`cZgca YcbY`Y`gY`k ]h]ci hWYUfmiUW\_bck`YX[ ]b[ `hY`gci fW`cZVcffck YX`a UHYf]U`cf`]XYUg`]g  
d`U[ ]Uf]ga "

5WUXYa ]WbZcfa Uh]cb

7CI FG9'9J5@! 5H€B'5B8'89J9@CDA 9BH

Gh XYbhZYXVUW\_\Ug\YdYX'hc'g\UdY'UbX'XYj Y'cd'h\]g'Wci fgYz]bWi X]b[ 'ZYXVUW\_cVHU]bYX'Zca'cb!  
]bY'Yj U'i Uh]cbg'Ug'dUfhcZI BGK 'g'Ug'dUfhcZI BGK 'g'a m9I dYf]YbW'dfcW'gg"Mc'i 'UfY'\][\`m  
YbWci fU[ YX'hc'Wca d'YH'gi W\ 'Ub'cb!]bY'Yj U'i Uh]cb'hck UfX'hY'YbX'cZHYfa "': YYXVUW\_UbX'gi [ [ Ygh]cbg  
dfcj ]YX'k ]"VY'ja dcfhUbh]b]ja dfcj ]b[ 'hY'Wci fgY'Zf'Z h'fY'gh XYbtg"

85H9G'HC' BCH9

FYZf'hc'A m BGK 'Zcf'a dcfhUbh8UH'gžUj U]UV'Y'Uh